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ROBERT STEENECK, Acting Data Systems Engineer

Punched Card Transmission on Telegraph Switching Systems

PUNCHED card information has been handled over telegraph circuits for some time through the use of both tape-to-card and card-to-tape devices. This method of handling is an off-line operation and is quite satisfactory for many applications. There is, however, often a need to handle card information directly on line and to provide handling means that will be compatible with modern telegraph switching facilities.

The Western Union "Telecard" system now in its prototype stage provides such "on-line" means. In both sending and receiving telecard units, a Type 024 or Type 026 IBM Card Punch fitted with a read in-read out harness is used both to read and to punch the cards. The Type 024 Unit is in reality two machines in one in that it can be made either to read or to punch cards, as desired. The Type 026 Unit differs from the 024 only in that it also prints on the top of the card as it punches. The read in-read out harness gives electrical access to almost all functions within the machine, terminating these circuits on two 40-conductor receptacles.

Establishing Compatibility

The first condition for establishing compatibility between card punch and telegraph circuitry requires the negative d-c power generated within the punch unit to be grounded. Since the direct current is obtained from a bridge rectifier connected directly to the a-c power wiring, it is necessary first to isolate the alternating current before grounding the direct current. This is accomplished by supplying all a-c power to the punch through an isolation transformer.

A paper presented before the Winter General Meeting of the American Institute of Electrical Engineers in New York, N. Y., February 1961.

The code language of the punched card, of course, is quite different from that of a telegraph system. The card employs a 12-level code which recognizes 48 combinations; 26 are assigned to the alphabet, 10 to digits, 11 to symbols, and 1 to space. No combination contains more than 3 selected levels.

The telegraph system employs a 5-level code which produces 31 useable combinations and a blank combination which is deleted in many switching systems. Two of the combinations are reserved to shift from alpha to nonalpha combinations and vice versa. In the reading process a card may be stepped through the machine, as required, one column at a time. Code translation can thus be accomplished without storing more than the single character being processed.

In stepping a card through the 024 or 026 unit, however, the card is first advanced and then read. Thus at the beginning of each card the first step of the card normally reads not column one, but column two. It is thus necessary to program the first step so that the read pins are activated without any advance of card. After that, normal step-and-read functions may be used. This read-without-step program must be followed not only at the start of each card but also after each automatic skip of card information.

In the reading process a column probe of the card is made by 12 pairs of reading pins, each pair corresponding to one level of the 12-level card code. By using two probe pins per level, reliability of reading is greatly increased.

Each code combination read from the card is stored in transistor "flip-flops," one for each card code level. The character corresponding to the code thus stored is identified by diode logic and converted to a 5-unit telegraph code combination. Con-

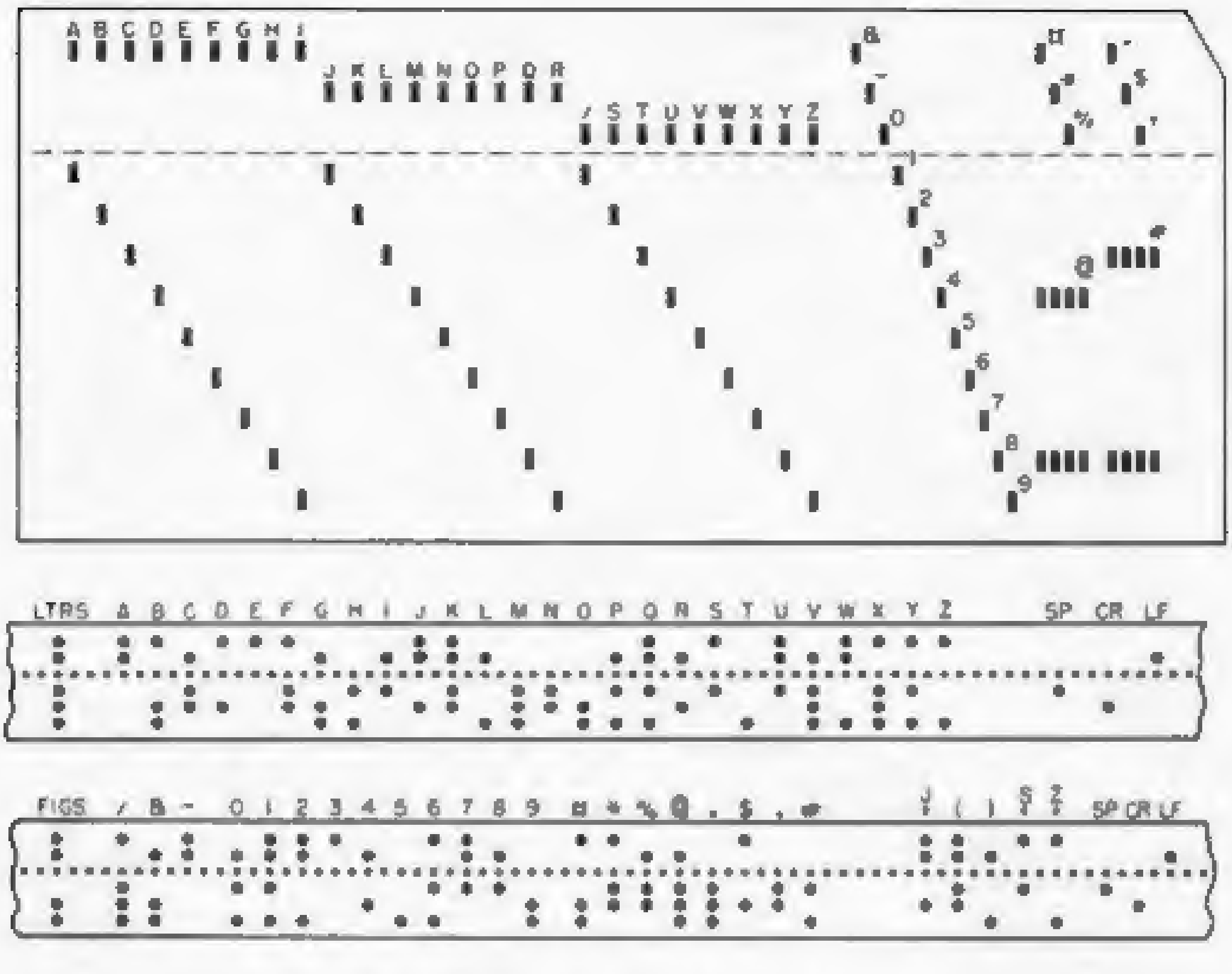

Figure 1. 12-level card code and 5-level telegraph code

version could be made to any other data code if so desired. To obtain a telegraph signal the five units are serialized and a start and stop pulse added to each combination.

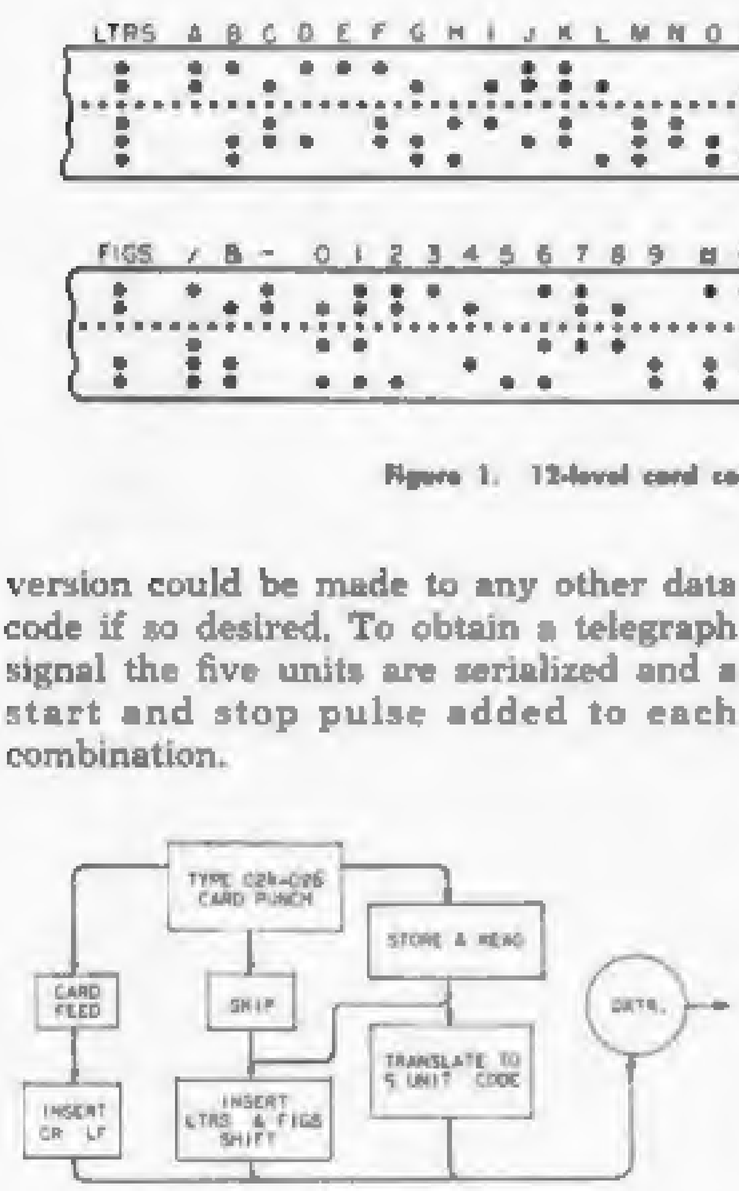

Figure 2. Block diagram of sending unit

The card code, having 48 combinations, adequately registers alpha, numeric and symbolic information without requiring any letter-shift or figure-shift combinations. Since the telegraph system requires figure- and letter-shift combinations, it is necessary to halt the card stepping and reading process whenever a change in type of information is detected and locally to generate the shift combination required. This is accomplished by a pair of transistor flip-flops which not only select the type of shift character desired but also properly program its insertion into the telegraphic output.

Program Drum

In transmitting information from cards it is often desirable to skip over card columns that are not desired for transmission. For this purpose there is associated with each card machine a program drum which revolves in synchronism with the stepping of the card. When fitted with a properly punched card, program contacts can be actuated at precise intervals to perform the skip functions that may be desired.

On point-to-point circuits the time consumed in the skip process can be accounted for by halting transmission during skip periods. When transmitting into

telegraph switching systems, however, halting of transmission alone results in no halt of reception unless null characters are transmitted during the "no information" interval. Either the letters-shift or figures-shift combination is used for this purpose.

Program circuitry is provided to insert carriage return and line feed at the end of each card making it possible to monitor the card transmission on a page teleprinter if desired.

This is the basic equipment that converts card code information to teleprinter signals.

The bridging of the code language barrier now makes it possible to start out with card information and automatically print this information in proper locations on a check, a bill of lading, an invoice or any of the many document forms used in the conduct of business.

In the creation of business documents, it is necessary to "program in" additional carriage return, line feed, space and tabulation signals to print the card data in proper places on the business form. Solid state circuitry, relays, rotary switches or punched tape readers controlled by a program card drum or by information within the card itself may be used for this purpose.

Error Checking

With the handling of data the problem of error checking must be taken into consideration. A total check of the accuracy of both alpha and numeric information can be made in several ways all of which are quite costly. In the handling of most data, however, the numeric portion is usually the most important part of the entire information. Numeric data, fortunately, may be protected easily by simply rearranging combinations in the 5-unit telegraph code that are assigned to six of the ten digits.[1]

In this reassignment all ten-digit code combinations will contain a fixed ratio of three marking and two spacing bits. An error in the transmission of any digit will now have but rare chance of producing another digit, but instead will produce some obviously meaningless symbol which will stand out as errored information. It is also possible to make this digit error detection automatic if desired.

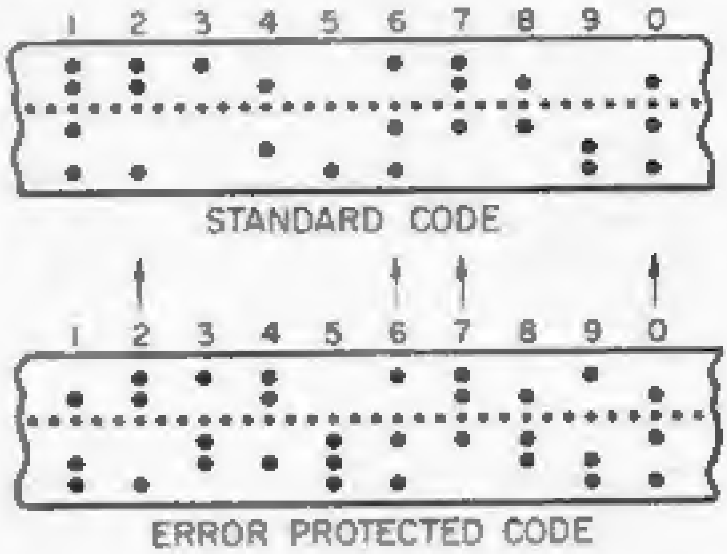

Figure 3.

This change in code can be made in a few seconds on a Type 28 receiving teleprinter by a substitution of code boxes. In the telecard translating units a wafer switch is provided to make possible the use of either the protected numbers code or the standard code, as desired. The telecard receiving unit converts received 5-level teleprinter code combinations to 12-level card code combinations in much the same way as the reverse process was effected at the sending terminal.

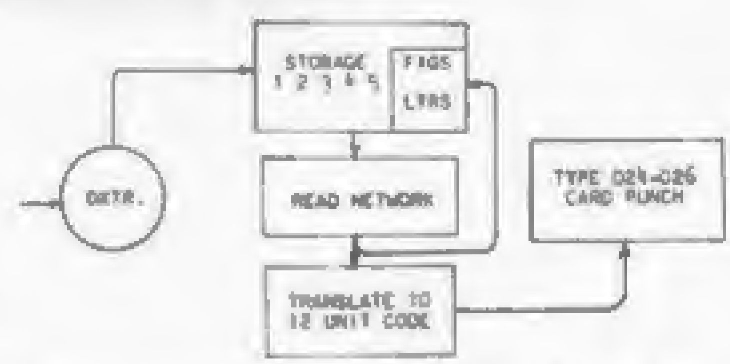

Figure 4. Block diagram of basic receiving unit

Each teleprinter signal is first received and its 5-bit selection stored in transistor flip-flops. A sixth flip-flop is used to register on shift combinations and to store each shift condition until a change in shift is indicated. A diode network is used with this storage to identify the character selected. All 32 letters selections and all 32 figures selections are identified.

After the received character is thus identified, it is converted to its corresponding 12-level card code combination by means of another network of diodes. The punching of the card is accomplished by energizing interposer magnets within the card punch that correspond to the code levels desired. Activating any of the 12 interposer magnets sends the machine through an automatic punch cycle. The only timing requirement is that the interposer magnets be released before the end of the punch cycle.

Auxiliary Functions

This is basically all that is required to convert telegraph signals to punched cards. In practical operation, however, much greater versatility is required. In many applications not all telegraphic information is wanted in card form. It is, therefore, necessary to activate and deactivate the card punch, as desired. This can be accomplished through the use of various figures combinations in the telegraph code.

For example, it would be quite logical to bracket the information in telegraphic text that is to be punched into the cards. The left-hand parenthesis sign (upper case K) could then be made to activate the punch and the right-hand parenthesis sign (upper case L) to deactivate the machine. With this simple arrangement, bracketed information is automatically punched into cards. If it be desirable, the carriage return function may be made to release a card, thus starting each line of information with a new card.

It is also possible to tie stunt functions into the extra program drum furnished with the card punch read in-read out harness. Twelve contacts are provided which can be made to connect with a common bus during any desired combinations of card columns by fitting the drum with a properly punched program card.

The Western Union "Telecard" equipment, just described, by bridging the card data — telegraph language barrier, not only makes possible the creation of fully automated "on-line" data communication systems, but also allows switching networks now handling administrative messages to be used for this purpose.

Reference

1. Error Checking Possibilities Concealed within the 5-Unit Code, ROBERT STEENECK, *Western Union Technical Review*, Vol. 14, No. 2, April 1960.

A biographical sketch of the author appears in the April 1960 issue of Technical Review.

ROY K. LEWIS, Jr., Project Engineer — Telegraph Equipment

Switching Telegrams to Local Lines — Plan 38

IN TODAY'S rapidly shrinking world, the need for faster and better communications is ever present. Recognizing this fact, another more rapid means of handling the company's public message service at large traffic terminals was contemplated. This new means, known as Switching System Plan 38, is now in operation in three of the nation's busiest cities, New York, Chicago, and Washington, D. C.

Switching System 38 has brought notable improvements in public message handling in these cities. For one, messages now received in the Plan 38 switching center are received in the form of printed-perforated tape. A switching clerk on reading the destination of the message has but to push a button to send the message along to its local destination. This has eliminated manual repunching of the message. Another improvement is the increase of the operating speed of trunk circuits from 65 to 76-2/3 words per minute. Probably the most important improvement is "page reception on trunks." Over 60 percent of the traffic handled by Switching System 38 terminates in a "burster" type page copy teleprinter. With this printer, the message is printed as it is being received on a standard Western Union blank, ready to be delivered to the customer. This saves considerable time and labor over the former method of gumming the received message tape on a standard Western Union blank.

The block diagram, Figure 1, depicts the principal sections a message must go through when handled by Switching System Plan 38. Messages are originated either by a customer utilizing branch office facilities, or by a tie-line customer, both of which are connected to a nearby terminal office and usually work into some type of switching system such as Plan 31 or Plan 35. From this associated switching system, the message will proceed to a reperforator center, where it is routed; if destined to be sent into a Plan 38 office, the message will be switched to a local sending position. These local sending positions in the reperforator center are associated with a Tape-to-Page Translator 8100. Messages are here converted to page copy (as explained in subsequent paragraphs) from whence they proceed over the trunk line and are received at the Plan 38 switching center. There a switching clerk will give the message its final routing, and will push-button it to one of the five sections shown in Figure 1. From the receiving section the message will be edited by the receiving clerk and delivered to the addressee.

It should be noted at this point that Switching System 38 is a "receiving only" type system; that is, messages are received from distant reperforator centers and delivered to local customers. All traffic locally generated and destined for other cities will be sent out over some other system such as Plan 31 or Plan 35.

Primary Switching Center

Exploring the actual equipment used in Switching System 38, let us begin with Tape-to-Page Translator 8100, which can most probably be considered the backbone of the entire 38 System. Since the branch or tie-line operator has no way of determining whether or not his message will be received on a page printer, all traffic sent into the 38 System must be translated into page copy. The 8100 Translator prepares the message so that it can be received properly on any type of page printer. Here are a few of the translator functions: (a) carriage return and line feed characters are inserted in the proper location in the message text when not pre-

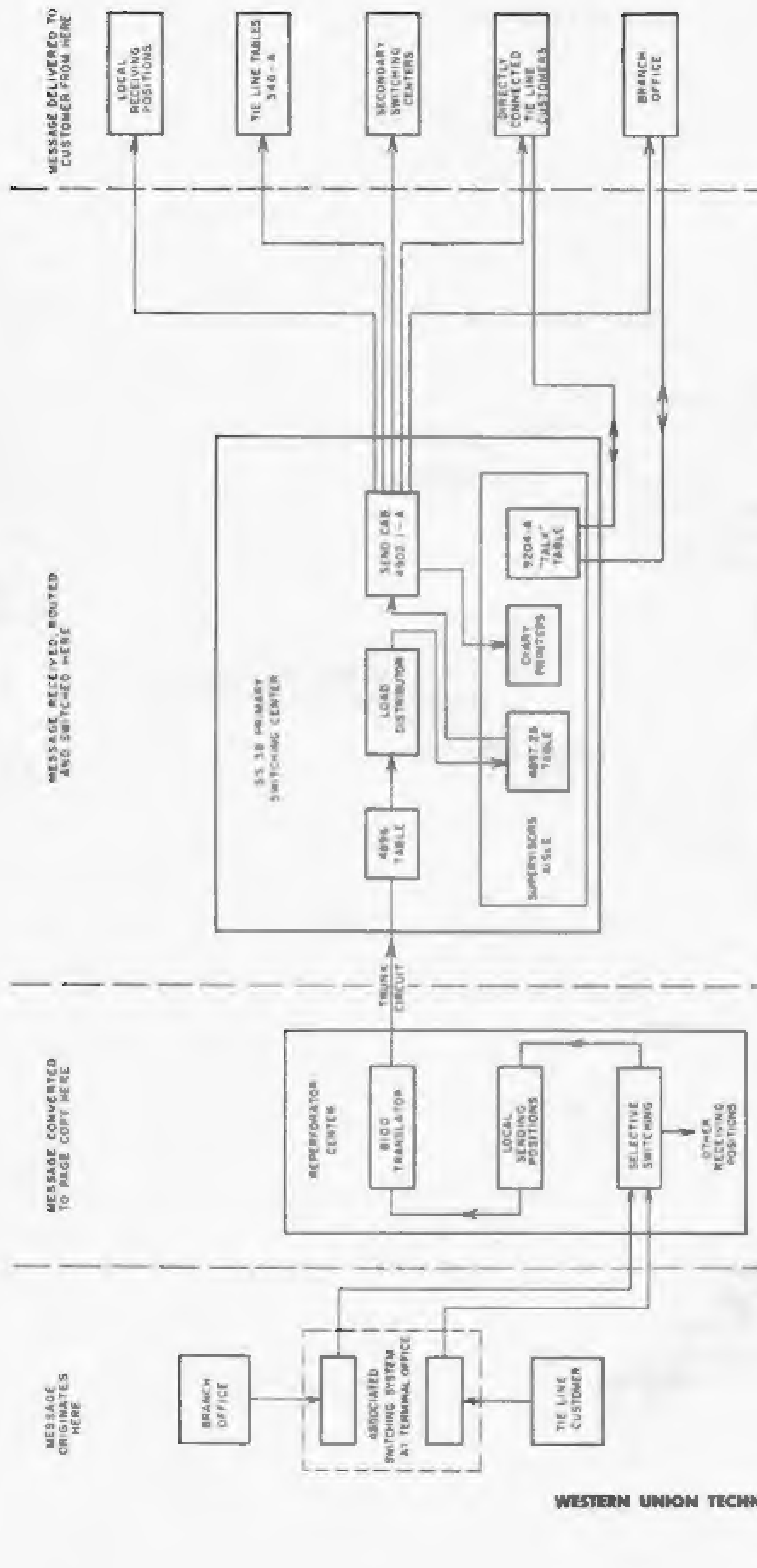

Figure 1. Block diagram of Plan 38 switching system

viously put in by the originating operator; (b) no single line can contain more than 70 characters (the translator counts the number of characters in each line and automatically inserts CR, LF on the first spacing character after 58), and (c) each message shall consist of 16 lines to fill up a uniform message blank, i.e., if the text of the message is not 16 lines long the translator will automatically insert enough line feeds to step the message blank out of the burster printer

The translated message will now be sent over a trunk circuit into the primary switching center of Switching System 38 which is comprised of Printer-Perforator Tables 4896 10-A These tables each contain two Printer-Perforators 39 25-A for receiving the incoming messages. The message, as it is being received in the form of printed-perforated tape, will flow from the printer-perforator to the pins of an associated Transmitter-Distributor 5032 4-A. When the first character of the received message reaches the pins of the transmitter-distributor the tape will stop and a light will be illuminated on the switching turret above the distributor-transmitter, signalling to the switching clerk that a message is waiting to be switched. The clerk will read, on the printed portion of the tape, the name of the person or firm, or the address to which the message is being sent. She will then refer to her routing charts which will tell her which of the possible 60 destinations the message will take

Let us assume that this is the leading portion of the tape message as seen by the switching clerk: PB003< . P LLA002 PD WUX NY< JAMES JONES CO< 225 LAFAYETTE ST N Y

The switching clerk will look up any unfamiliar name, e.g., James Jones Co in her routing chart. Let us assume that the James Jones Co. is a customer connected to the New York office by facsimile. The routing for the message will be "LL" or "locals." The switching clerk will push the "LL" button on her switching turret. The message waiting lamp goes out and a "stand-by" lamp lights, indicating that the message will go to "LL" as soon as a circuit has been established from her

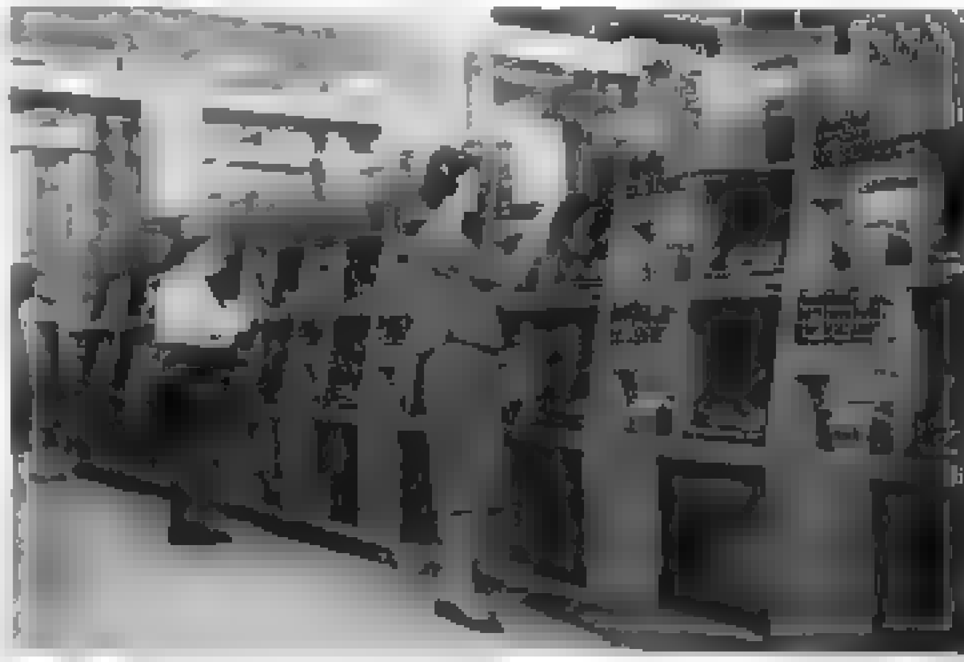

Photo H 2665-1

Figure 2. Plan 38 switching aisle at New York City

position to a receiving printer. In the New York office there are 20 circuits from the switching center feeding cross-office to the local receiving printers or "LL" printers. These are all burster type printers operating in conjunction with Receiving Rack 8510. A circuit will be established by means of a load distributor, Line Finder Rack 6920-A, part of the switching center. This rack automatically connects one of the 20 "LL" printers to the requesting switching turret. When the connection is made, the stand-by lamp at the switching turret goes out, and the "operate" lamp comes on. Before the message leaves the switching aisle, however, an automatic number is sent out to the receiving printer. As each printer receiving from the switching center has a specific numbering machine associated with it, the numbers will always be in sequence unless line trouble develops.

Another function yet to be performed before the message or the automatic number is sent is to connect a diary printer to the sending line. This diary printer, part of the supervisory section of the switch

ing center, will record the automatic number as it is sent out plus the originating number of the message being sent

With the diary printer connected the automatic number will now be sent as NB025. As soon as the automatic number is complete, transfer circuits will disassociate the automatic numbering machine from the circuit and cut in Transmitter-Distributor 5032 4-A in the switching aisle, thus sending the message

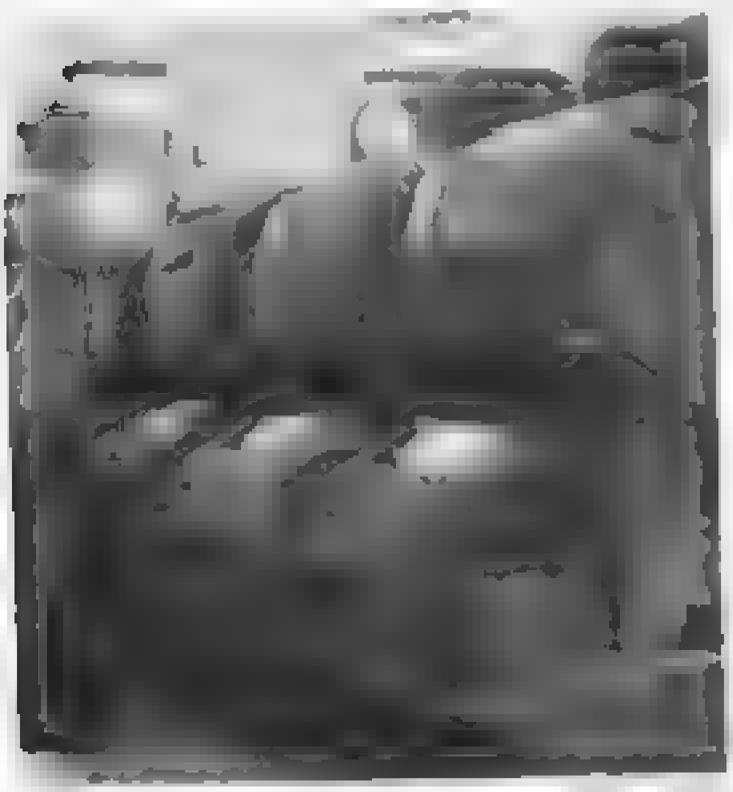

Figure 3. Checking diary printer record in supervisor's aisle of Plan 35 switching system

The diary printer will record "NB025 PB003," and then automatically disconnect itself from the line. The receiving burster printer will copy the entire message as follows

NB025 PB003
P LLA002 PD WUX NY
JAMES JONES CO
225 LAFAYETTE ST NY

and continue until the message is complete. When the message is complete as signified by two sequential carriage return (CR) characters followed subsequently by a letters character, the sending line will be released by the switching position, extinguishing the "operate" lamp at the 4896.10-A Table. Note that the two sequential CR characters will be separated from the letters character by the required number of line feed (LF) characters necessary to step the message blank out of the burster printer. The message received at the local burster printer will move to an editing desk, where any necessary corrections will be made in the text From there it is delivered to the facsimile section where the message is placed on a facsimile drum and sent to the James Jones Co

Types of Equipment

Printer-Perforator Table 4896.10-A has already been mentioned as part of the primary switching center. A maximum of 75 such tables may be used in a complete switching center for a total of 150 operating positions. These tables, each with two receiving printer-perforators, can receive messages from either two separate sending positions, or from one sending position, utilizing both printer-perforators on an alternate reception or "flip-flop" basis. Of the 60 push buttons on each sending position, 24 are capable of multichannel selection, that is, operating through a line finder as did the message to "LL." The other 36 are associated with only one receiving printer and bypass the line finder

All sending lines have their own automatic numbering machines which are housed in Sending Circuit Cabinet 4902 1-A. Each cabinet contains line connection equipment plus numbering machines for 20 sending lines, and in addition houses two Numbering Machine Distributors 11.8-A. These are used to transmit the automatic number and are shared by the sending lines. The numbering machines are either Type 7-A, 11-A, or 7014 29-A. Associated with each 4902 1-A Cabinet, and hence 20 sending lines, is one Top Line Printer Rack 9202-A, located in the supervisors' aisle and containing two 15.17-A Type Printers which copy the automatic number and first line of each message sent out from the system. This printer has contacts which read CR and LF characters. The first CR LF sequence received will be read by the printer and cause it to be disconnected from the par-

ticular sending line it was copying. The rack also contains an alarm bell which will sound if any diary printer is connected to one line longer than 10 seconds.

Also located in the supervisory aisle are Monitor Control Tables 4897.2-A which contain "close out" switches for each sending line. Directly above each switch is a supervisory lamp which tells the supervisor the condition of the line at all times. The switches have three positions closed out, open for traffic, and special. With a switch in the "closed out" position, no traffic can be sent over the associated line from the switching aisles and the supervisory lamp will glow steadily. In the "open for traffic" position, traffic can be sent over the line from any switching turret and the supervisory lamp will be extinguished. In the "special" position the line may be used only by the supervisor for special traffic. Here also the supervisory lamp will be extinguished. These and other lamp indications are as follows

(a) Switch in "closed out" position
 - Steady Glow—line conditions normal
 - Slow Flash—line conditions not normal

(b) Switch in "open for traffic" position
 - Lamp Out—line conditions normal
 - Fast Flash—line has gone open
 - Slow Flash—Sending position transmitter stopped during message transmission
 - Steady Glow—Temporary stop placed on line from receiving position

(c) Switch in "special" position—no indications

On the switching turret push-button panel of the 4896.10-A Tables a neon lamp is located directly above each push button. If the supervisory switch associated with the sending line of a particular push button is closed out, its associated neon lamp will glow steadily. If the sending line is open for traffic, the lamp will be extinguished. If the sending line is in the special position the lamp will flash.

Figure 4 Central Supervisor Table 9204-A

Since the switching center is a "one-way" system, i.e., a sending only system to the branch office or tie-line customer there was a requirement of a "talk" facility between the switching center supervisor and the branch office supervisor or directly connected tie-line customer. These talk facilities are used only for RQ's, BQ's, closing number checks and matters of that nature. Supervisory Table 9204-A was designed for this purpose. This table consists of two 100-wire Plan 2 concentrator type turrets. Associated with each turret jack is a lamp which lights when a branch office supervisor or tie-line customer is calling in. It also contains a time stamp and a message holder rack. Two 2BS Type tape printers are mounted on this table and can be plugged into any jack for "talking" purposes.

This supervisory table is located in the supervisors' aisle along with the diary printers and monitor control tables.

Auxiliary Switching Center

In Chicago and New York the 60-sending line push-button panel was found to be inadequate in that there were more than 60 branch offices and locally required lines. Therefore, secondary switching centers were set up which handle traffic for lighter loaded branch offices and directly connected tie-line customers.

Let us follow the routing of a message received over a trunk circuit destined for a tie-line customer. It will be received in the primary or "A" system on one of the 4896 10-A Tables. Having looked up the message routing, the switching clerk now depresses one of the secondary system buttons (in this case the "C" system button), sending the message cross office to a receiving 4896 9-A Table. This table is similar in appearance and function to a 4896 10-A Table, but all circuits from the former table terminate in a single receiving printer and cannot operate on a load distributor basis. At this 4896 9-A Table, the message is received and another switching clerk, after checking the routing chart, depresses the appropriate push button and the message is sent directly to the tie-line customer. The message will be received on a page copy printer.

Again, as with the primary or "A" system, the message will be preceded by an automatic number. Immediately following the automatic number, however, will be the time and date the message is sent. This time and date is inserted automatically in the line by Time and Data Transmitter 5136-B. Upon completion of the automatic time and date, the message from the Transmitter-Distributor 5032 4-A at the 4896 9-A Table will start. The message will be completed when the two sequential carriage return characters followed by a letters character are transmitted.

Since directly connected tie-line customers will frequently receive collect messages, these customers must be billed from the local office. Therefore, the entire message as sent to the customer must be monitored, not just the first line as with the message sent to "LL." In order to do this, Top Line Printer Rack 9202-B is used

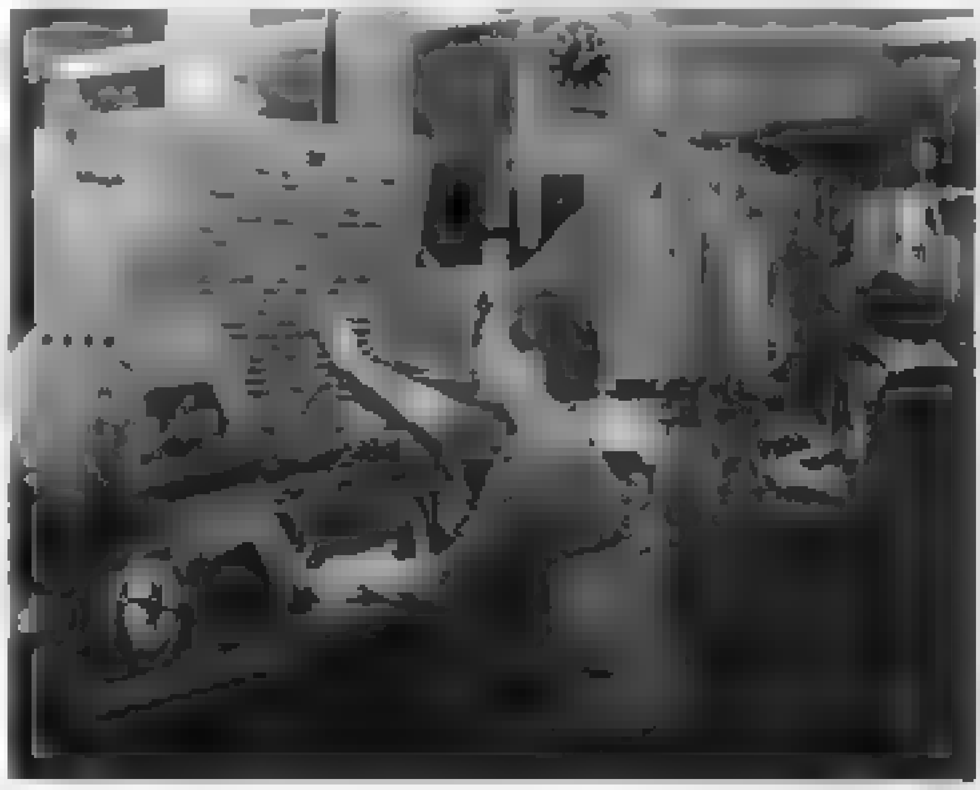

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Figure 5. Tie-Line Switching Tables 346-A

in conjunction with the Sending Circuit Cabinet 4902 1-A. The 15 17 Type printer is equipped with contacts to read for CR and letters characters, and will disconnect itself when the end-of-message characters are read, not on the first carriage return-line feed as was the printer used with the "A" system.

The alarm signal for this "full copy monitor" will not sound after ten seconds as before, but will sound only if the automatic number is not sent within ten seconds, or if the letters character does not follow the second carriage return, signifying the end of message, within ten seconds.

In the Washington installation, no auxiliary systems are used, and directly connected tie-line customers are found in the primary system. The tie-line customers are assigned to push buttons 1

through 20 and 41 through 60, which have full copy diary printers. Push buttons 21 through 40 are used for local and branch office traffic and have only the message first line copied

In all three installations there are tie-line customers who, because of lighter loads, are not connected directly to the Plan 38 switching center. For this reason Tie-Line Switching Tables 346-A were installed to handle these customers. Messages received in the switching center destined for them are push-buttoned to a receiving 36 Type printer-perforator located on the 346-A Table. The message is then sent by the torn-tape method via a Plan 2 concentrator to the customer

Special Features

A few of the special features of the 38 System include facilities for inserting automatic time and date in all sending circuits. Temporary sending stops may be put on local positions, thus enabling the receiver from the 38 Switching Center to stop traffic temporarily over his line while changing paper or making minor printer adjustments. The multichannel or load distributor circuits can be set up to operate either on a "first available" or "rotate" basis. When set on a first available basis, all messages will be sent over the "A" channel unless it is busy. Only then will the "B" channel be used. When set on a rotate basis, the first message will be sent over the "A" channel, the second over the "B" channel, the third over the "A" channel, and so forth, in a rotating [redacted]

Automatic reconnect service can be installed. This is used when all traffic received over a particular trunk circuit is destined for one particular branch office or customer. The switching clerk can push-button the first message, and all subsequent messages will follow to that destination. The destination can easily be changed by the switching clerk if desired Sending-stop push buttons can be installed in the supervisory aisle to enable the supervisor to stop transmission over any sending line whenever desired.

As the operators are becoming more familiar with the Plan 38 equipment, and the maintenance section is becoming more proficient in trouble shooting, Plan 38 operation is gaining as an efficient means of handling the company's public message traffic. In the New York office, around 35 to 40 thousand switches are made per working day

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ROY K. LEWIS, JR., Project Engineer in the Telegraph Equipment division, received his B.S. in Electrical Engineering from Virginia Polytechnic Institute, Blacksburg, Va., in June 1955. He thereafter joined the engineering staff of Western Union where he remained until April 1956. He then served two and one-half years in the Army, two years of which were with the Army Security Agency in Germany. Mr Lewis returned to the company in October 1958, since which time he has worked primarily on the design, development and testing of switching systems. He is a member of IRE.

Technical Associates of Western Union — V
TelePrompTer Corporation

TelePrompTer Corporation, originator of electronic speech-prompting equipment, celebrated its tenth year of operations in October 1960, with expanding activities in a broad range of integrated Group Communications services.

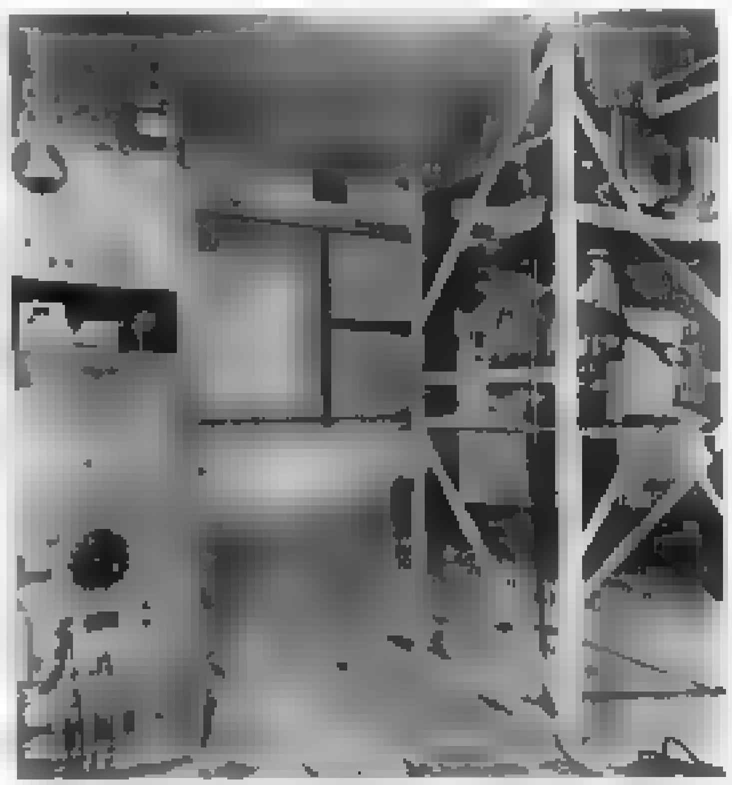
Later this year TelePrompTer expects to begin experimental operation of its revolutionary plan for subscription or "participation" television, Key TV. This concept,

On the left is a model of the Key-TV box which will permit home television viewers to select subscription programs and even answer back, creating a new concept of "participation" television.

which enables home viewers to select programs and *answer back*, probably will be tested first in one or more of the six community antenna systems owned and managed by TelePrompTer Corporation.

TelePrompTer Corporation has communications systems and equipment in approximately 70 military and government installations and is serving as audio-visual consultant for educational programs at several universities. The company's successful performance as official presentation and communications specialist at the Democratic National Convention in Los Angeles was widely publicized and received commendation from convention officials.

The company is a major producer of large-screen closed-circuit telecasts, enabling industry to hold multicity sales meetings and new product demonstrations reaching vast numbers of representatives. A dramatic demonstration of this medium was last summer's record-breaking telecast to 229 locations in 160 cities of the Floyd Patterson victory over Ingemar Johansson for the Heavyweight Championship of the World.



Backstage view of rear-screen projection installation at The Quartermaster General's briefing room, Washington, is typical of communications systems developed by TelePrompTer Corporation for government, armed forces industry and education.

Equipment developed and supplied by TelePrompTer Corporation includes such specialized electronic devices as the Telepro 6000 front- and rear-screen slide projector; TeleMation system of automation for presentation effects; and Presidential adjustable lectern with built-in prompter controls.

At last report, Western Union owned 15 percent of the outstanding shares of TelePrompTer Corporation.

ALBERT R. ALBRO, Project Engineer Facsimile

Facsimile Test Chart Used on United States Air Force Weathermap Network

WHEN installation of the Air Force weathermap network was arranged, it was apparent because of the size and importance of this network that a modified form of test chart would be needed to check the entire network for proper operation

In order to make it easy for operating and maintenance personnel to use the test chart, it was decided that a "Go" type chart (so designed that all information on it should be transmitted and recorded satisfactorily) would be the best. This type differs from many facsimile test charts which contain a great deal of information that cannot be expected to be transmitted over a circuit with good resolution but is primarily for use in the laboratory

Since the chart was to be a "Go" type, it was necessary to determine what information should be included in it and to find out the capabilities of the weathermap transmitters and recorders. A number of preliminary charts containing various types of information were made and tests were conducted on equipment in the laboratory Finally, from the results of these tests a preliminary chart containing all the required information was assembled

Field Tests

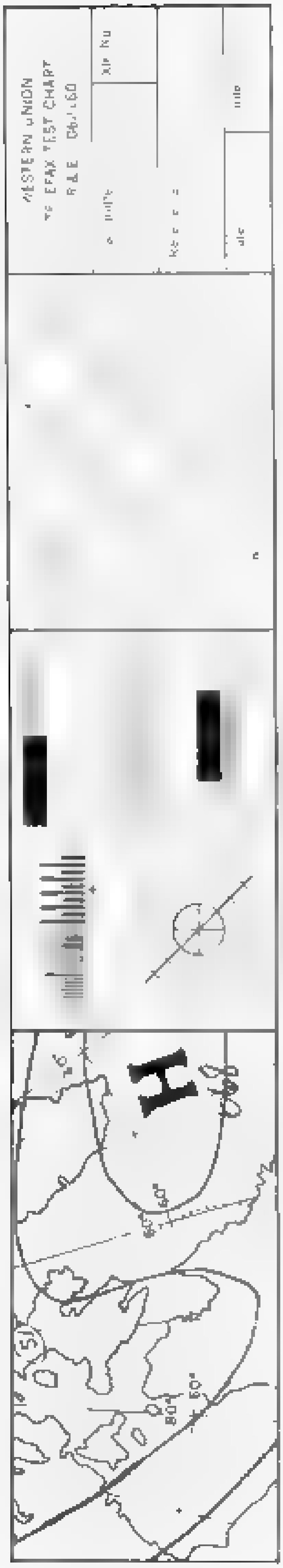
Although this preliminary test chart worked very well in the laboratory, it was necessary before having a final one printed to see how it would perform when transmitted over the actual network facilities, With the cooperation of the United States Air Force, test transmissions using the chart were made from the National Weather Analysis Center, Suitland, Maryland, to the entire network. The Air Force then returned all the recorded copies to the Western Union Research and Engineering Department for evaluation. The received copies indicated that this test chart would do the job it was designed to do.

It was now necessary to have a final test chart printed which would be exactly the same as the preliminary one with respect to information, print density, and dimensions. Line drawings, print density information, photographs and a metal vertical bar pattern consisting of .020-inch and .040-inch lines accurately made in the Western Union model shop were given to an engraver to make the necessary printing plate.

The weathermap equipment transmits, daily, many feet of numerical data in addition to weathermaps. Therefore it was felt that a sample of this numerical data should be included in the test chart. Because the data printers use a unique type face, no ready-made font of type with this face was available, and it was necessary to obtain assistance from the data printer manufacturer. With his assistance a homogeneous sample of copy using this particular type face was obtained for the chart. This sample was given to the engraver who was then able to make the complete engraving.

When the printing plate was completed, a print was made and to insure that the plate was satisfactory a test transmission was again made from the National Weather Analysis Center at Suitland to the entire network. The recorded copies were returned to the Research and Engineering Department where they were checked and found to be satisfactory

The printing plate was given to a printer who was able carefully to set up the plate and print the charts. A picture of the test chart, called Western Union Telefax Test Chart R&E-062160, is shown. It is 17½ by 3 inches, printed on a sheet of good quality clay-coated white paper 18 by 6 inches



This illustration of Teledex Test Chart R&E-042160 has been reduced and is not suitable for test purposes

The chart was made 18 inches wide in order to be the same width as the maps that the Air Force transmits with the facsimile equipment. The scanning length of the chart was made 3 inches in order to keep the transmit time as short as possible. The 3-inch scanning length requires approximately 3 minutes to transmit. It has been printed on a 6-inch sheet in order to make the chart easier to handle and to provide room for writing any extra information when necessary.

Four Chart Sections

Referring to the picture it can be seen that the test chart has been divided into four sections as follows.

Section 1 (Map Section) is a portion taken out of a typical map that is transmitted over the network. This section shows how received maps will look when received on weathermap recorders.

Section 2 consists of various items which will check electrical and mechanical adjustments on the transmitters and recorders and will also check the transmission characteristics. This section will be used in analyzing the map and the numbers section (Section 3) in case of trouble.

The following items have been included

a. .020-inch and .040-inch vertical lines used to check resolution.

b. A circle pattern used to check the index of cooperation (proper recorder paper feed and transmitter scanning rate). The diagonal line through the circle is used to check for irregular line feed and scanning.

c. Black and gray tone bars used to check for proper level and contrast adjustments. The black bars have been printed full black and the gray bars have been screened so that the density is approximately 50 percent of full black

d. A sample of pica typewriter type screened so that the density is approximately 80 percent of full black

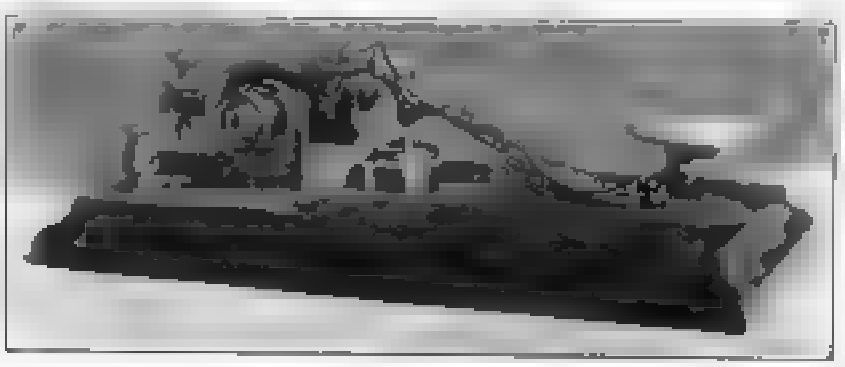
Section 3 (Numbers Section) contains a sample of the type which is transmitted

with this equipment. It has been screened so that the density is approximately 80 percent of full black in order to simulate the actual transmitted copy

SECTION 4 lists the number of the test chart for reference purposes and, since tests will be made periodically, boxes have been included which indicate where the test chart was transmitted from, where it was received, the date and time of transmission

The Air Force will transmit the test chart to the network once a week. Each transmitter location (there are six at present) will be on a rotating schedule. When the chart is transmitted the map section and the numbers section should reproduce legibly and indicate to the operating personnel that the equipment is operating correctly If these two sections do not reproduce legible copy it indicates that the equipment is not operating correctly and requires that a maintainer be called to correct the condition. The second section of the test chart will assist the maintainer in locating the trouble.

ALBERT R. ALBRO, presently on the staff of the Facsimile Engineer in the Research and Engineering Department received his Bachelor of Electrical Engineering degree from Pratt Institute in 1948. After holding engineering positions with the Long Island Lighting Company and Western Electric Company, he joined Western Union in 1951 and was assigned to the staff of the Facsimile Applications Engineer in the Applied Engineering Section of the Plant and Engineering Department. Mr Albro served with the United States Air Force as a Radar Technician. He is an associate member of AIEE



Silver telegraph key with ivory finger button used by President Ulysses S. Grant to signal the opening of the Centennial Exposition in Philadelphia in 1876. Presented to the Western Union Museum by S. T. Shirrow from the memorabilia of his father, Chief Engineer and Vice President of Postal Telegraph and Cable Company.

FRED W. SMITH, Assistant to Telegraph Equipment Engineer

A Proposed New Teleprinter Code for Error Detection

IN RECENT years a considerable amount of study has been devoted to error-detection and error-correction systems for telegraph and data communications. A number of articles on this subject have appeared in TECHNICAL REVIEW and many papers on the subject are presented each year before various engineering societies.

Emphasis has been placed on error detection, since a detected error can always be corrected, and also on use of systems and methods for data communication, where an undetected error can prove costly The various codes used in telegraph and data communications have received a great deal of attention and many new codes have been developed for special purposes, with emphasis on error detection and error correction. The 5-unit Baudot code, long recognized as illogical in many respects, has also been studied[1] with a view to improving the character assignment to provide some protection against undetected errors. To date, no 5-unit code with an improved character assignment has been used in the United States, but such a code is now in limited use in Europe

The 8-Level Data Code

In data communications there is a definite trend towards use of codes having more than five intelligence levels, or pulses, and some communications specialists feel that the 8-level code will some day be the standard code for data and message communication. One 8-level code which appears to be favored for this purpose at present would utilize five of the intelligence levels to obtain 32 possible code combinations. A sixth level would be used as a shift level; that is, to distinguish between upper-case (figures or symbols) and lower-case (letters) printed characters. A seventh level would be used for a vertical parity check; that is, a seventh marking pulse would be automatically added where necessary to insure that every combination contained an odd (or even) number of marking pulses. An eighth level would be used for control purposes and could be utilized for any purpose required. The five levels in this code used for obtaining the 32 code combinations could employ either the present Baudot code assignment or a new and more logical assignment to provide some protection against undetected errors

Use of an 8-level code to obtain only 32 possible code combinations for selecting printed characters or teleprinter functions appears to be highly inefficient because of the increased line frequency required for a given speed of operation and because of the more complex mechanical apparatus required to handle an 8-level code. The primary purpose of this article is to propose at least one attractive alternative to the use of an 8-level code in future telegraph systems, and to attempt to stimulate further study of a possible standard code for future telegraph and data communications use. Since adoption of a new 8-level code in the telegraph industry would involve extensive design of new equipment and/or redesign of existing equipment, a most careful and thorough consideration of all factors involved is justified in order to avoid placing undue limitations on the versatility and flexibility of any new system developed.

The principal advantage in using a sixth level as a shift level appears to be that it makes possible a keyboard more like a typewriter keyboard than any teleprinter keyboard now in use; that is, a 4-row keyboard which permits transmitting a number without first operating a figures-shift key can be designed. To send an upper-

case character other than a number, however, it would be necessary simultaneously to depress a shift key and a character key in order to insert the sixth marking pulse. This might be attractive to customers who do not use the present 3-row teleprinter keyboards.

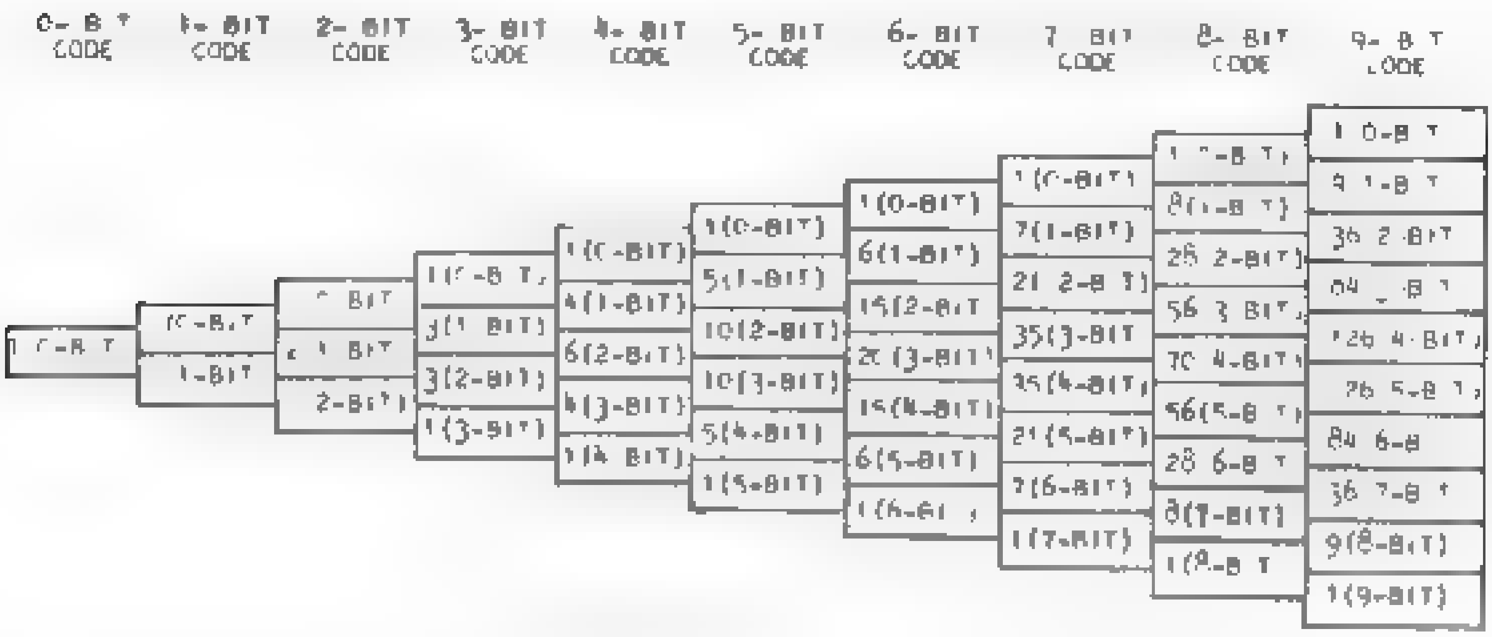


Figure 1. Steeneck's analysis chart of binary codes up to nine levels.

Use of a vertical parity check for each character transmitted provides appreciable protection against occurrence of undetected errors and a vertical parity check can be made with relatively simple circuitry. However, such a check is not nearly as effective as a horizontal parity check and the use of an additional intelligence level solely for the purpose of providing a vertical parity check deserves careful study. In any event, preliminary tests indicate the latter to be only 90-percent effective.

Control characters are, of course, essential in most modern telegraph and data communications systems and it is essential to provide for such characters in any future code developed. Again, however, use of one additional intelligence level solely for this purpose should be carefully evaluated.

A Proposed New 6-Level Code

In a recent article in TECHNICAL REVIEW[1] Robert Steeneck pointed out some of the error-checking possibilities concealed within the 5-level code. Subsequent to preparation of his article, Steeneck developed a "Christmas Tree" analysis chart of all binary codes up to and including the 9-level code. Steeneck's analysis chart (Figure 1) shows, for each code, the number of combinations possible for each number of marking pulses (or bits) possible. For example, in a 2-level binary code there is one combination which contains no marking pulses, two combinations which contain one marking pulse, and one combination which contains two marking pulses. While it is not possible to have a binary code containing zero levels, Steeneck added a theoretical zero-level code for esthetic reasons.

The possibilities revealed by the Steeneck chart and the design work now being done on at least one 6-level teleprinter led to consideration of the possible use of a 6-level code with the sixth level being used for purposes other than shift control. Referring to Figure 1, it can be seen that the 6-level binary code contains 6 combinations with a single marking pulse, 20 combinations with "triples," and 6 with "quintuples." There are 15 "doubles" and 15 "quadruples." The combination with no marking pulse and the one with all 6 pulses marking complete the 64 combinations possible with a 6-level binary code.

Note that there are 32 combinations which contain an odd number of marking pulses and 32 which contain an even num-

ber, if zero is considered an even number It is thus possible to obtain 32 combinations of the 6-level code, each of which will have an odd number of marking pulses, or 32 combinations, including the all spacing combination, each of which will have an even number of marking pulses. This, of course, is the same number of combinations obtained with the standard 5-unit Baudot code

Figure 2 shows all of the combinations in the 6-level code which contain an odd number of marking pulses, and Figure 3 shows the combinations which contain an even number of marking pulses. (Note that the code levels in both figures have been numbered from 0 to 5, rather than 1 to 6, to correspond to the numbering system recommended by the AIEE Committee on Tape Standardization.) Thus, either of these two groups of combinations could be used to obtain the 32 different characters now commonly used in telegraphy, and either group would provide a built-in parity check, either odd or even, depending on the group chosen. If either of these two codes is adopted for future record communications use, a serious effort should be made to make it a "common language" code, equally useful for message and data communications. Some of the factors which should be studied will be discussed in the following paragraphs in an effort to determine which of the two proposed codes appears more attractive

Protection against errors can be provided to a considerable degree by careful assignment of the most frequently used characters to the code combinations least susceptible to errors. In making such an assignment, the following factors are most significant:

1 *A decision should be made as to which characters should be given maximum protection and an order of priority established for the 32 characters*

2 *The many types of errors which occur in telegraph communications and their frequency of occurrence should be determined and an order of priority of the code combinations established, based on the frequency of occurrence of the most common types of errors*

3. *The two orders of priority should then be matched to obtain the most desirable code assignment.*

Perhaps there are other factors which could be considered but these appear to be the most important

Several years ago, Western Union made a study of the frequency of occurrence of the letters of the alphabet in the English language. Although this study was not based on telegraph messages, but rather on newspaper stories, it is unlikely that telegraph messages would be radically different. The order of occurrence of each

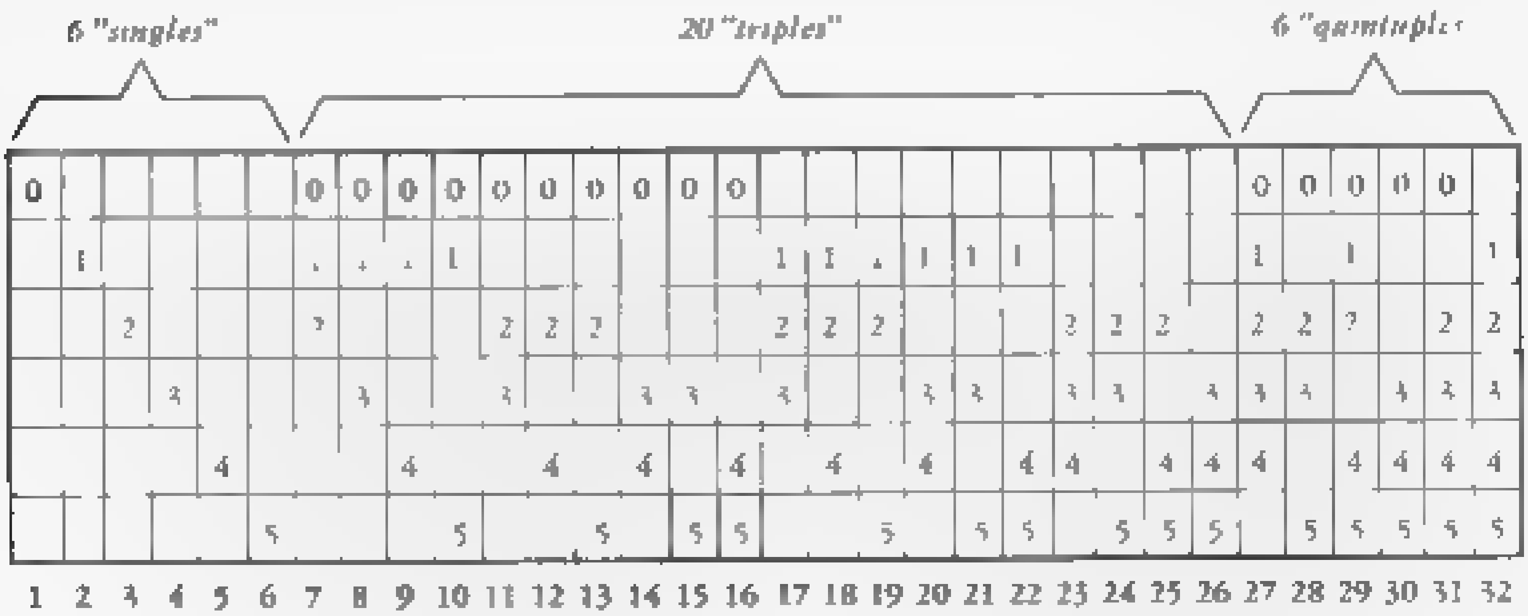


Figure 2. A 6-level binary code using only combinations with an odd number of marking pulses. A number denotes a marking pulse and absence of a number denotes a spacing pulse

letter, with the frequency of occurrence per 1000 letters, was

Letter	*Occurrence Per 1000 Letters*	*Letter*	*Occurrence Per 1000 Letters*
E	126	U	30
T	90	P	27
R	83	M	25
I	76	Y	21
N	76	G	18
O	74	W	14
A	72	V	13
S	58	B	11
D	40	X	5
L	36	K	3
C	33	Q	3
H	33	J	2
F	30	Z	1

Considering only the letters of the alphabet, a priority based on the foregoing tabulation could be assigned. However, in telegraph and data communications, protection of numbers is of utmost importance, since it is difficult to detect an error occurring in a number whereas an error in a letter in normal English can usually be detected and corrected. Also, protection of the five teleprinter functions (carriage return, line feed, figures shift, letters shift and space) must be considered.

It would be highly desirable to assign the ten numerals to the ten most frequently used letters in the alphabet, so that maximum protection could be given simultaneously to the numbers and to the ten most frequently used letters. Unfortunately, this would involve a radical change in the layout of 3-row keyboards. With a 4-row keyboard, the change could be made without seriously affecting the present standard layout, since the numbers keys would be separated from the letters keys and the code combinations assigned to the numbers could correspond to any group of ten letters.

Reassignment of the numbers would make it necessary to change some of the punctuation marks, but this could probably be tolerated. On the other hand, the 3-row keyboard is based on the physical relationship between the numbers and letters keys on standard typewriters and any change would make it difficult for a touch typist to use the touch system on such a keyboard. For purposes of this discussion, then, it will be assumed that

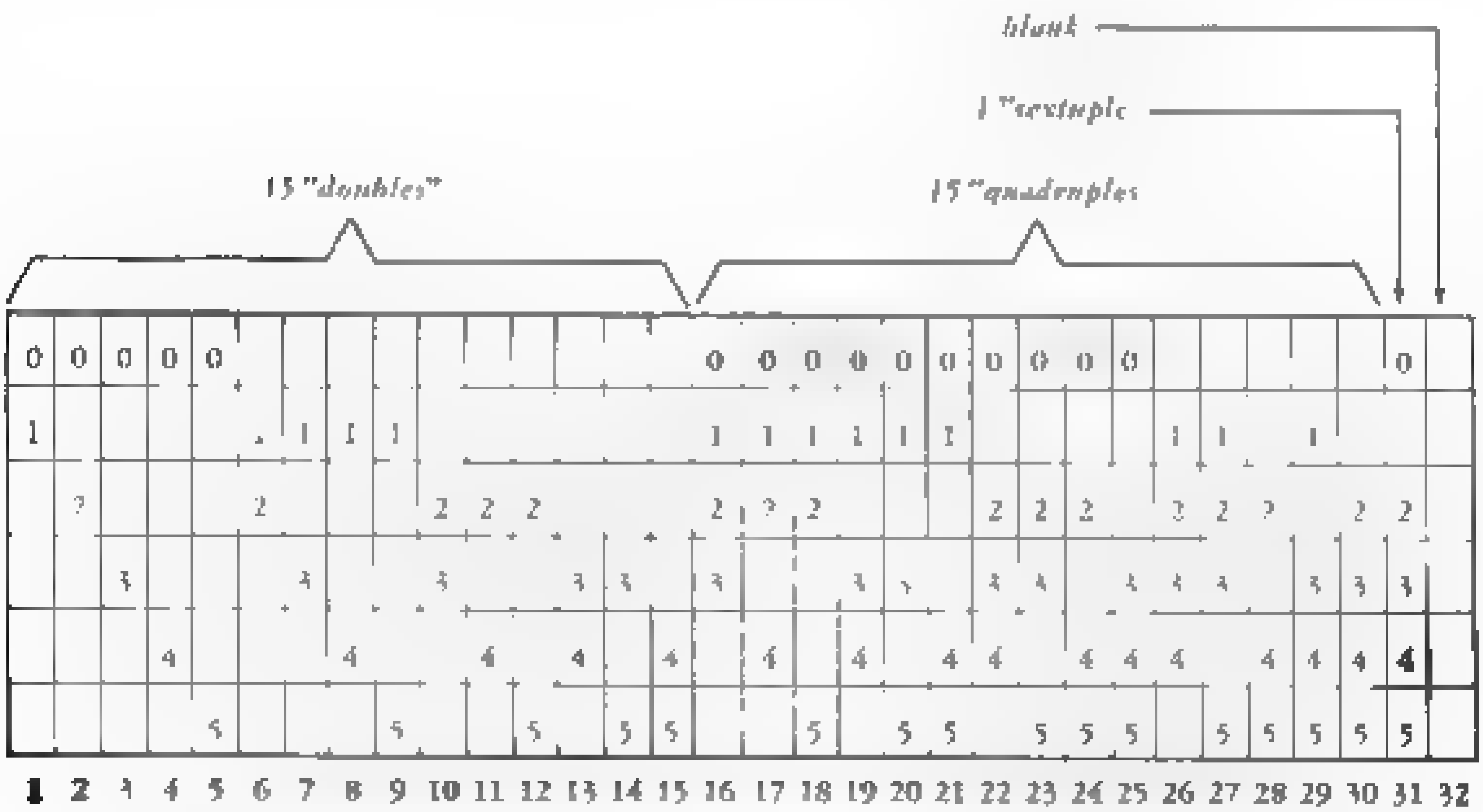


Figure 3. A 6-level binary code using only combinations with an even number of marking pulses. A number denotes a marking pulse and absence of a number denotes a spacing pulse.

3-row keyboards will continue in use in telegraph communications and that the numbers cannot be assigned to other letters, i.e., the present assignment must be maintained. The numbers one through zero are at present assigned to the letters QWERTYUIOP, in that order. The letters QWYUP are not among the ten most frequently occurring letters of the alphabet, but the remaining five in the "numbered" group are. All ten of the letters in this group must be protected, however.

An "average" word consists of five letters, so that a teleprinter must perform a spacing function an average of one time in every six operations of the teleprinter. The frequency of occurrence of the spacing character is thus approximately 200 times per 1200 characters and this frequency is even higher than that of the letter E. Although loss of, or an error in a spacing character seldom results in an undetected error, this character does deserve a high priority in the code assignment because of its high frequency of occurrence. Errors in the figures and letters shift characters seldom result in an undetected error and they are less frequently used than the space; therefore, these characters deserve less priority than the space. However, it is more difficult to correct errors due to shift failure without resending the message than it is to correct a spacing error, so that these two important function characters should be given some priority over little-used characters. Similarly, the carriage return and line feed characters seldom result in an undetected error but a single failure of one of these two characters can result in making an entire line of printing unintelligible. They thus deserve a rather high priority, perhaps higher than that assigned to the letters and figures characters.

Considering the three foregoing factors (that is, frequency of occurrence of letters, protection of numbers, and protection of functions), a number of logical orders of the priority of the 32 characters now used could be developed, depending on the weight given to each factor. The following order is suggested as just one possibility:

Priority	*Character* L.C.	U.C.	*Priority*	*Character* L.C.	U.C.
1	Space		17	A	-
2	E	3	18	S	'
3	T	5	19	D	$
4	R	4	20	L	)
5	I	8	21	C	:
6	O	9	22	H	#
7	U	7	23	F	¶
8	P	0	24	M	.
9	Y	6	25	G	&
10	W	2	26	V	;
11	Q	1	27	B	?
12	Car. Ret		28	X	/
13	Line Feed		29	K	(
14	Figures		30	J	Bell
15	Letters		31	Z	"
16	N	,	32	Blank	

Types of Errors and Frequency

A number of studies have been made by Western Union to determine the types of errors and their frequency of occurrence in messages switched over the public message network and over one private wire network. The statistics resulting from these various studies do not agree in all respects but there is agreement as to which types of errors occur most frequently.

Loss of a single marking pulse is the most common type of nonoperator error and the field studies reveal that from 37.7 to 72 percent of all nonoperator errors are due to loss of a single pulse. The first pulse is lost more frequently than any other and the fifth pulse ranks second in frequency of loss. In normal message traffic each of these two pulses occurs in 40 percent of all characters transmitted. The third pulse ranks third in frequency of loss and occurs in 53 percent of all characters. The second pulse, which occurs in 48 percent of all characters, and the fourth pulse, which occurs in 40 percent of all characters, together account for fewer total errors due to loss of a single pulse than does the first pulse. The studies also revealed that a character containing a single marking pulse is more susceptible to error due to loss of a single pulse than a character containing several marking pulses.

Gain of a single pulse caused from 4.9 to 14.3 percent of all errors. (These results

do not agree with controlled laboratory tests made on marginal equipment and circuits, which show that 90 percent of all errors[1] are due to gain or loss of a single pulse.) The remaining errors were caused by simultaneous loss and gain of pulses, loss of an entire character, gain of multiple pulses, and loss of multiple pulses, in that order of frequency

It seems logical to assume that in a 6-level code the first and sixth pulses transmitted would be most susceptible to loss, rather than the first and fifth If this assumption is accepted, any 6-level code adopted should assign the lowest possible priority to combinations containing both of these pulses and the next lowest to combinations containing only one of these pulses. Referring to Figure 1, it can be seen that a 4-level code contains six combinations with two marking pulses, one with four marking pulses, and one with no marking pulses. Therefore, a 6-level even-parity code will contain eight combinations with an even number of marking pulses, without either a first or sixth marking pulse, if the blank combination is included However, use of the blank combination is considered undesirable and it is seldom used. Figure 1 also reveals that eight combinations with an odd number of marking pulses are available without using either the first or sixth pulse

A high degree of protection against undetected errors in numbers and vowels should be provided by putting all numbers and all vowels in the same group; that is, in a group of combinations each of which contains the same number of marking pulses[1] Since 4 of the 5 vowels have numbers assigned to the upper case, only 11 combinations in a group are necessary to accomplish this; it could be done with either the odd-parity or even-parity 6-level code. In the odd-parity code shown in Figure 2, only "triples" could be used. In the even-parity code shown in Figure 3, either "doubles" or "quadruples" could be used In the odd-parity code there are only 4 combinations of "triples" which contain neither a first nor a sixth pulse In the even-parity code there are 6 "doubles" which contain neither a first nor a sixth pulse and only one "quadruple" which contains neither of these two pulses Use of the even-parity code with the numbers and vowels assigned to the "doubles" therefore offers some advantage over use of the odd-parity code. The following code assignment is therefore proposed for the even-parity code, considering all of the factors previously discussed

Priority Number	*Combination No. (Fig. 3)*	*Code Combination*	*Character L.C.*	*U.C.*
1	6	– 1 2 – – –	Space	
2	7	– 1 – 3 – –	E	3
3	8	– 1 – – 4 –	T	5
4	10	– – 2 3 – –	R	4
5	11	– – 2 – 4 –	I	8
6	13	– – – 3 4 –	O	9
7	26	– 1 2 3 4 –	Figures	
8	9	– 1 – – – 5	U	7
9	12	– – 2 – – 5	P	0
10	14	– – – 3 – 5	Y	6
11	15	– – – – 4 5	W	2
12	1	0 1 – – – –	Car Ret	
13	2	0 – 2 – – –	Line Feed	
14	3	0 – – 3 – –	Q	1
15	4	0 – – – 4 –	A	–
16	27	– 1 2 3 – 5	Letters	
17	28	– 1 2 – 4 5	N	,
18	29	– 1 – 3 4 5	S	'
19	30	– – 2 3 4 5	D	$
20	16	0 1 2 3 – –	L	)
21	17	0 1 2 – 4 –	C	
22	19	0 1 – 3 4 –	H	#
23	22	0 – 2 3 4 –	F	¶
24	18	0 1 2 – – 5	M	
25	20	0 1 – 3 – 5	G	&
26	21	0 1 – – 4 5	V	,
27	23	0 – 2 3 – 5	B	(
28	24	0 – 2 – 4 5	X	/
29	25	0 – – 3 4 5	K	(
30	31	0 1 2 3 4 5	J	Bell
31	5	0 – – – – 5	Z	"
32	32	– – – – – –	Blank	

Note that the priority previously given was modified to place all of the numbers and all of the vowels in the "doubles" group, so that loss or gain of a single pulse or of two pulses would not result in printing a wrong number or a wrong vowel. The seventh ranking combination in the order of priority was then available for a character other than a number or vowel The figures shift was assigned to this combination because of its importance in data

communications. Unfortunately, this resulted in a relatively low priority for the letters N, A and S, all three of which are among the ten most frequently occurring letters in the alphabet

The above priority list can be divided logically into three groups. The first group consists of priorities 1 through 7, which do not contain either a zero or fifth marking pulse. The space and 6 printing characters in this group would account for 649 out of every 1200 printing and spacing characters in normal message traffic. The second group consists of priorities 8 through 23, each of which contains either a zero or fifth pulse, but not both The printing characters in this group would account for 473 out of every 1200 printing and spacing characters. Also, 3 of the 5 function characters are in this group. The third group consists of priorities 24 through 32 and each of these combinations contains both a zero and a fifth marking pulse. The characters in this group would account for only 78 out of every 1200 printing and spacing characters and there are no function characters in this group

Perhaps a more exhaustive analysis of the error protecting possibilities in a 6-level code would result in considerable improvement in the foregoing code assignment, but this one at least would be a tremendous improvement over the 6-level code now in limited use in the telegraph industry, where the sixth level is used only for shift-unshift, a vertical parity check is not possible, and the code assignment is more or less haphazard.

The proposed code would prevent a printing error due to loss or gain of a single pulse. The 15 "doubles" combinations would prevent a printing error due to loss of two pulses, and the 15 "quadruples" would result in printing a J (or bell in upper case) if two pulses were gained. In most cases, a J (or bell symbol) erroneously printed for another character would be an obvious error and therefore would not go undetected. All of the combinations would be protected against undetected loss or gain of more than two pulses. This code offers no protection against simultaneous loss and gain of the same number of pulses within a character combination. This could happen occasionally if the error rate was unusually high and the chances of gain and loss of pulses were about equal. In practice, however, the error rate is never that high on an operating circuit and error conditions usually consistently produce pulse losses or, more rarely, consistently produce pulse gains. Therefore, the probability of compensating errors occurring in this type of error check is quite remote.

It might appear wasteful of transmission time to use only 32 combinations out of the 64 available with a 6-level code. However, the 32 combinations which contain an odd number of marking pulses could be used for such purposes as switching control or horizontal parity checking. Switching characters or horizontal parity checking characters could be preceded by a "conditioning code" combination to bypass temporarily the vertical parity checking circuit and, if desired, to put the teleprinter in a nonprint condition. Following the switching or horizontal parity checking combinations, an end-of-switching or end-of-parity-check character could restore the circuit and the teleprinter to the normal printing condition. The 6-level code used in this manner would make considerably more efficient use of transmission facilities than the 8-level code previously described and would also make it possible to use a higher transmission speed for a given bandwidth

Mechanical Apparatus for the 6-Level Code

Design of tape transmitters, distributors, distributor-transmitters, keyboard perforators, and nontyping reperforators for use with the proposed code would present no special problems and, in fact, many of these units are available for use with a 6-level code. They could be used with the proposed code with little or no modification. A transmitter or distributor-transmitter could be used with a parity-check circuit which would stop transmission and actuate an alarm when the reading pins read an odd number of marking pulses. A similar circuit could be used with verifying contacts or reading contacts on a reperforator to perform the same function

At present there is no start-stop teleprinter or typing reperforator which could be readily modified to operate with the proposed code, but there appear to be no serious obstacles in the design of such units. A typebar teleprinter such as the Siemens and Halske Type 100[2] could be designed readily for six levels and it is possible that a large number of standard parts could be used in the 6-level teleprinter. A teleprinter using an aggregate-motion type of selector would be more difficult to design and it is doubtful that any of the present aggregate-motion selectors could be modified to use many of the standard parts. These comments also apply to start-stop typing reperforators.

A teleprinter with a 2-color printing mechanism such as that used on most European teleprinters[2] could be used to detect a parity-check failure by energizing a magnet to shift the red half of the ribbon to the printing position. The parity-check circuit could be arranged to lock the magnet in its operated position until manually released, so that all characters following the error would print in red. An asterisk or other symbol could be printed on receipt of the blank character to guard against undetected loss of two marking pulses in one of the "doubles" combinations. A more detailed study would no doubt reveal other possibilities. A teleprinter could be designed to space on every signal train received, whether a valid character or not. This would give excellent protection against undetected loss or gain of a single pulse, the most common cause of all errors, without the use of a parity-check circuit.

Conclusion

It is doubtful that it will ever be economical to design a communication system to provide 100-percent protection against errors, but it is economically feasible to design a reliable system approaching 100-percent accuracy. The 6-level code proposed here offers extensive possibilities. Apparatus designed for use with this code would provide a very large decrease in both detected and undetected errors, without providing parity-check circuitry, but it is not possible with the meager error-study data available accurately to predict exactly how much improvement could be expected.

New carrier systems have been developed which considerably reduce transmission errors and newer systems which will result in even greater improvement are under development. Since mechanical equipment is the source of a large percentage of errors, a new and drastically different approach to error prevention in mechanical apparatus is needed to keep pace with the improvement being made in transmission facilities. It is hoped that this article will stimulate a study of this need and perhaps lead to a new approach to the error prevention possibilities within the 6-level code. It is possible that 6-level equipment such as that proposed could be incorporated into one of the broadband switching systems now under development for data communications, with resulting simplification in the system and consequent reduction in cost.

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A biographical sketch of the author appears in the July 1958 issue of TECHNICAL REVIEW

S. A. ROMANO, Project Engineer Facsimile

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Modification of A Facsimile Weathermap Recorder Test Set

The test set is used in conjunction with all Westrex Corporation (formerly Times Facsimile) RJ-3 Recorders installed on the United States Air Force Weathermap Network and on the National Weather Bureau Network. Due to the fact that the receiving stations on these networks are equipped solely with recorders, the problem was encountered of providing a portable test set which for all practical purposes simulated the various signals transmitted. Westrex Corporation developed such a test set and designated it as Times Facsimile Test Set CT-1.

Modification Needed

The test set as designed by Westrex provided only three different outputs. It produced a chopper (bar) pattern, steady carrier, and phasing pulses for various speed recorders. These signals were sufficient properly to maintain a weathermap recorder. However, recently the operation of the recorders was changed to conform with a requirement stipulated by the United States Department of Commerce that all recorders on the National Weather Bureau Network start and stop on definite tone frequencies. Originally the recorder started by responding to steady carrier and stopped by responding to lack of carrier. The recorder now starts by detecting 300 cycles which is modulating the carrier, and stops by detecting 450 cycles which is modulating the carrier. Since the test set as originally designed by Westrex Corporation did not produce the now necessary modulated carrier signal, it was desirable to design a simple modification kit which easily could be incorporated in the existing test sets in the field without returning the units to the manufacturer.

The purpose of this article is to describe the circuit developed to work in conjunction with the existing circuitry in the test set to produce a carrier signal modulated with either 300 cycles or 450 cycles.

The circuit designed consists of a transistorized Colpitts oscillator producing the 300- and 450-cycle-per-second tones; a common-emitter amplifier and a chopper-type modulator. Power is supplied by the power supply of the test set.

The oscillator essentially consists of transistor T-3 (see Figure 1) and a tank circuit. The tank circuit is composed of a toroid and two Mylar capacitors C_1 and C_2 which are selected to obtain the desired tone frequencies. Mylar capacitors were used in order to achieve the frequency stability required for the ambient temperature variation expected. The maximum variation of the tone frequencies due to temperature variation, from an average room temperature of 25 degrees C. to the extreme temperatures of —15 degrees C and +50 degrees C., is less than 1 percent. The tank circuit was designed with capacitors much larger in magnitude than any capacitance presented to the tank circuit by the transistor or the wiring. Thus, the tone frequencies are a function of the tank circuit only and not of the circuitry associated with it.

The tone frequencies are taken from the oscillator at point A (see Figure 1) and coupled to the common-emitter amplifier through a 0.1-mfd capacitor and a 10K-ohm resistor. The purpose of the 10K-ohm resistor is to prevent any loading of the oscillator by the amplifier stage.

This method of raising the impedance presented to the oscillator was preferred for several reasons to raising the input impedance of the amplifier stage itself by degeneration. In order to obtain the high input impedance desired from the stage, a

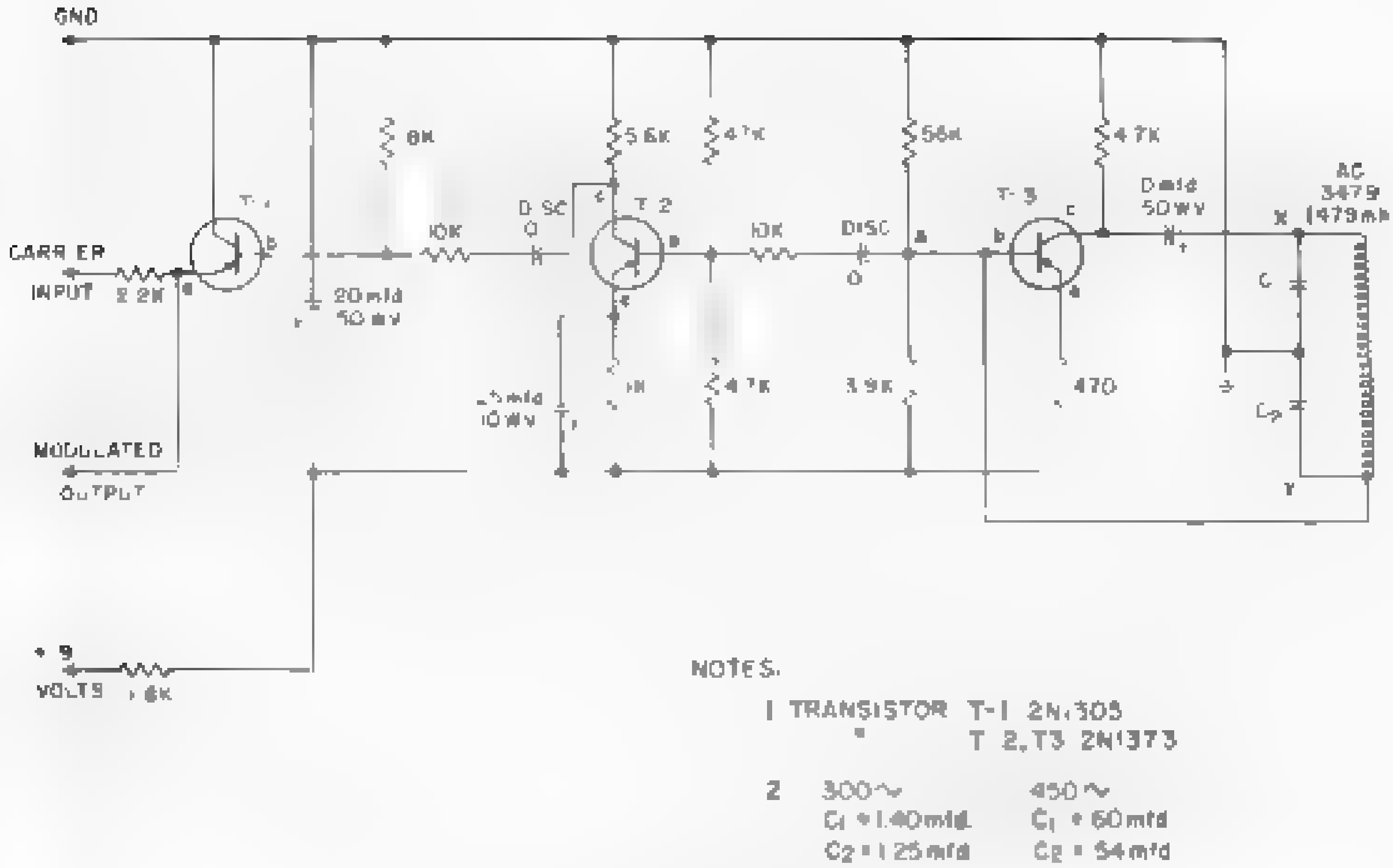

Figure 1 Start-stop signal generator schematic

great deal of degenerative emitter feedback (unbypassed emitter resistance) and large base biasing resistors would have been required. When using large base biasing resistors, the stage would not only be unstable with ambient temperature changes and vary in operation with different transistors (of the same type), but would also have an input impedance which would vary with any change in β (the common-emitter short circuit current gain) of the transistor. As a result the load impedance presented to the oscillator would not have been a fixed quantity which is undesirable

Degenerative emitter feedback (unbypassed emitter resistance) was not employed for another reason, this being that the amplifier stage is driven into saturation and cut off in order to square the tone frequencies as required. Hence, a stage of maximum gain was desired and harmonic distortion problems did not enter into the design considerations. Furthermore, normal changes of gain of the amplifier, as expected, will not appreciably affect the shape or amplitude of the output square wave signal since the stage is operated as mentioned above. Therefore, the chopper-modulator will be driven by a virtually constant amplitude signal. (Normally expected variations in the output voltage of the power supply will not appreciably affect the operation of the chopper-modulator because it is driven by a signal which is larger than the minimum amplitude required.)

To summarize then, the common-emitter amplifier (transistor T-2) shapes the tone frequencies into essentially a square wave and drives the chopper so that the output carrier signal is modulated in a square manner

The chopper-modulator is a single transistor, T-1, operating similarly to an opening and closing switch and driven by the squared tone frequencies. As a result, the carrier is interrupted at the tone frequency rate, either 300 cycles or 450 cycles. The theory of operation of this chopper circuit is as follows.

A carrier signal voltage divider is formed by the 2 2K-ohm resistor and the emitter (e)-to-collector (c) impedance of transistor T-1. The output signal is taken from the emitter (e) which is the junction of the 2.2K-ohm resistor and the emitter-to-collector impedance. This emitter-to-

collector impedance is a function of the conduction state of the transistor. If the transistor is in the cutoff state, the emitter-to-collector impedance will be very high (for example, approximately 1 megohm).

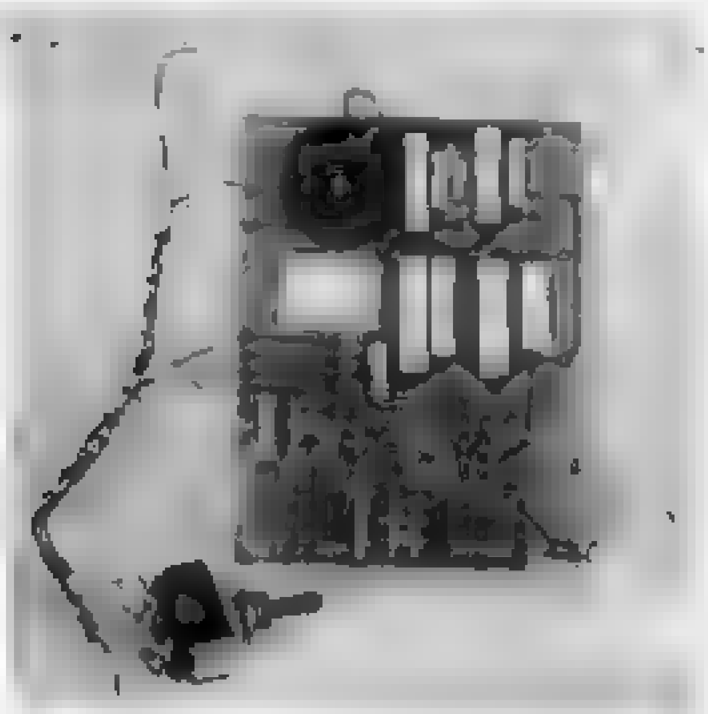

Photo R-11,866

Figure 2. Printed circuit board

If the transistor is in the fully conducting state, the emitter-to-collector impedance will be very low (for example, approximately 20 ohms). The conducting state of the transistor is determined by the base (b) driving signal—the 300- or 450-cycle tone frequency. When the base (b) signal is positive, the transistor will be cut off and the emitter-to-collector impedance will be high. When the base signal is negative, the transistor will be highly conductive and the emitter-collector impedance will be low. Therefore, the output carrier level (at the emitter) will be varied in accordance with the base driving frequency (300 or 450 cycles).

Due to space limitations, and to facilitate the modifying of existing test sets, the circuit was constructed on a printed circuit board (see Figure 2). This was then provided as part of a kit for modifying existing test sets in the field and has proved to be a practical and satisfactory arrangement.

S. A. ROMANO joined the staff of the Facsimile Engineer of the Research and Engineering Department in June 1955 after being graduated from Pratt Institute with a Bachelor of Electrical Engineering degree. He also has done some graduate study at Polytechnic Institute of Brooklyn. Mr. Romano is an associate member of AIEE and belongs to the Professional Groups on Audio, Circuit Theory and Engineering Management of IRE of which he is a member.

M. BARTOLOTTA received his Bachelor of Electrical Engineering degree from New York University in June 1950, after interrupting his studies for service in the United States Army. He joined the Telegraph Company in December 1951 and was assigned to the staff of the Facsimile Applications Engineer in the Plant and Engineering Department. He is presently on the staff of the Facsimile Engineer in the Research and Engineering Department. Prior to joining the Telegraph Company, he worked in the Material Laboratory at the New York Naval Shipyard and also was a field inspector for the Signal Corps. Mr. Bartolotta is a member of IRE.

PERCY L. MYER, Project Engineer   Telegraph Equipment Retired

Tape Motor Control for Trans-Lux Projectors in Series

A NEW YORK firm of office designers, while setting up an office for a large stockbroker in Los Angeles, proposed to arrange for a projector screen much larger than the normal 10-foot screen. To accomplish this it was thought that by using three projectors in series the desired result might be attained. The only question that arose was that of controlling the tape-pulling motors so that the three tapes would be moved simultaneously, a feature which could be demonstrated only by an operating model. Arrangements were made between the Telegraph Company and the projector company and a model set-up was developed which resulted in the following arrangement for controlling the tape-pulling motors.

Projector Operation

Where a projector is used in conjunction with a quotation Ticker 5-A for projection of printed quotations onto a screen, the movement of the printed tape across the field of vision of the projector is accomplished by the use of a tape-pulling motor. The motor is normally controlled by a mercury switch which is actuated by a loop of tape between the ticker and the projector. When the tape becomes taut it raises the arm of the mercury switch and opens the circuit to the tape-pulling motor to stop the motor and prevent breaking of the tape. As more tape is fed out by the ticker the arm of the mercury switch drops and closes the switch and the puller motor starts again. Since the puller motor always pulls the tape faster than it is being fed out of the ticker, there is, on the screen, an intermittent movement of the tape. It moves and stops according to the closing and opening of the switch.

When two or more projectors are arranged in series with each ticker spaced at a different interval with respect to its associated projector, it is possible to have the screens in series so that the projections appear as one continuous tape and the quotations starting at the right end of the right-hand screen move across the screens in succession. This gives an observer a longer period of time to look at a particular quotation, or he may see many more quotations on the screen at the same time.

It is obvious that it is desirable to have the tapes of each machine move and stop simultaneously otherwise the effect on the observer is distracting. The purpose of the tape motor control is to start and stop the motors simultaneously or as close to this as is reasonably possible. Since it is practically impossible to have two or more tickers feed out the exact same amount of tape for a given number of quotations, it is obvious that some provision must be made to correct for this variation as it may occur. Also the tape-pulling motors which are switched on and off do not have exactly the same characteristics when starting and stopping. The mercury switches do not all operate at exactly the same angle. All these factors must be given consideration and compensation made when necessary to correct for these variations and keep the tapes moving in a smooth manner. The tape motor control is devised to bring all tapes into register (i.e., correct relationship one to the other) each time any one of the motors is stopped by the tape becoming taut.

Snubber Magnet

To bring all tapes into register, a tape-snubbing magnet is mounted between the ticker and the tape loop which actuates the mercury switch. The tape is passed between the armature and the pole of this magnet and when the snubber magnet is

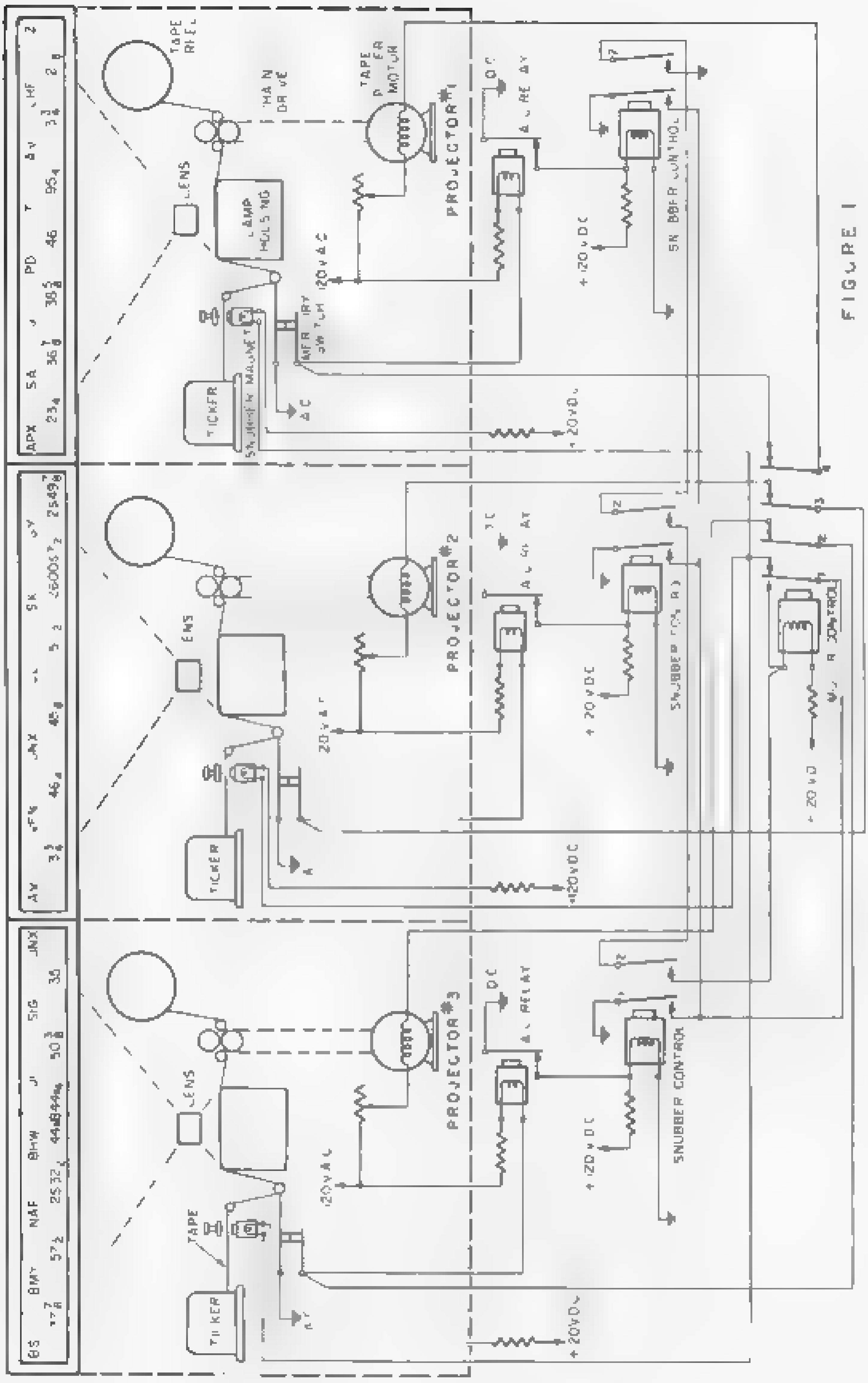
TAPE REEL
LENS
LAMP HOUSING
TICKER
PROJECTOR #1
PROJECTOR #2
PROJECTOR #3
+120VDC
120VAC
SNUBBER CONTROL
TAPE

FIGURE 1

energized it actually grabs the tape and holds it so that the tape-pulling motor, pulling the tape, will shorten the tape loop to open the mercury switch and stop the motor

Theory of Operation

The figure shows the tape-puller motor control for three projectors in series. Since the projected tapes move across the screens from right to left the projectors are numbered from right to left. Projector No. 1 has its ticker set as close to the field of vision as is reasonably possible and still provide the necessary space for the snubber magnet and the loop of tape for actuating the mercury switch which opens the circuit to the tape-puller motor when the tape becomes taut.

Projector No. 2 has its ticker spaced from the snubber magnet to the ticker at a greater distance than No. 1 by an amount that is equivalent to that length of tape that appears in the field of vision on the projector

Projector No. 3 is similarly spaced from the snubber magnet at a greater distance than No. 1 by an amount that is equivalent to double the length of tape that appears in the field of vision.

The snubber magnet is mounted on a bracket attached to the lamp housing of the projector. Tape from the ticker passes between the armature and the pole of the snubber magnet and then over a tape guide to loop around the actuating arm of the mercury switch. A screw with a rounded point in the center of the armature engages the tape to push it against the pole of the snubber magnet. (The screw engages the middle of the tape and thus prevents smearing the fresh ink on the printed tape.) When the snubber magnet is energized it holds the tape at that point and, as the puller motor continues to operate, the tape loop is taken up raising the arm of the switch until the mercury contact opens and the motor stops.

When the snubber magnet is energized, the ticker may keep on working and the tape fed out by the ticker will appear as slack between the ticker and the snubber magnet. This slack tape is taken up as soon as the snubber magnet is released. The tape-puller motor is always geared to operate the pulling wheels faster than the tape is fed out by the ticker. Thus the arm of the mercury switch is always riding on the tape and there is normally no slack between the ticker and the snubber magnet.

When all snubber magnets are energized at the same time and all tapes are thus held in their correct relative positions, the motors of all the pullers will be stopped and the tapes will be held in register, i e , in correct relative position.

As the snubber magnets are released, any slight accumulated slackness in the respective tapes, between the ticker and the snubber magnet, is taken up as the switch-actuating arms drop to close the mercury switches. Since all mercury switches would not normally close at the same time, when the snubber magnets are released it is necessary to ascertain that time when all the mercury switches have closed and then close all motor circuits simultaneously.

To determine the status of the mercury switches before closing of the motor circuits, there is connected to each mercury switch an a-c relay which is independent of the tape-puller motor and so connected to the mercury switch that it follows independently the action of the mercury switch. This a-c relay is always energized when the mercury switch is closed and is deenergized when the mercury switch is opened.

The contacts of the a-c relay are connected in a manner to short-circuit the winding of its associated snubber control relay whenever the a-c relay is energized The winding of the snubber control relay is always connected to battery and ground but its winding is energized only when the a-c relay is deenergized. Hence when its associated mercury switch is opened the snubber control relay is energized, and when the mercury switch is closed the snubber control relay is deenergized.

Each snubber control relay is provided with two "make" contact assemblies. A ground is applied to the No. 1 tongue of each relay. The front contacts associated with the No. 1 tongue of each of the

snubber control relays are connected together and through tongue No. 1 and its associated back contact of the motor control relay to the windings of all the snubber magnets. Each snubber magnet is provided with battery through its individual resistor. It is thus seen that when in normal operation any one of the mercury switches is opened by its taut tape, all snubber magnets are energized and all mercury switches are subsequently opened and all tape-puller motors stopped. Also all snubber control relays become energized and when this condition occurs a series circuit is established from ground through the No. 2 tongues and front contacts of all the snubber relays to energize the motor control relay.

When the motor control relay is energized it introduces an additional opening (in addition to the mercury switch) in each of the tape-puller motor circuits. This prevents the motor circuits from being closed for operation until the motor control relay is deenergized.

Also, when the motor control relay is energized it opens the circuits to all the snubber relays and, at the same time, applies a holding ground to the winding of the motor control relay. This holding ground is maintained until all snubber control relays have become deenergized.

With the release of the snubber magnets and the closing of all mercury switches with the resultant deenergizing of all the snubber control relays, the holding ground is removed from the motor control relay when it becomes deenergized closing all the motor circuits simultaneously. Battery for operation of the control relays is provided through a master control switch. When the switch is opened it removes all the controls and each of the tape-puller motors will operate independently with no snubber action.

An individual switch, not shown, is provided for each projector so that if it is desired to remove the control from any one it may be conveniently done by throwing the switch to its off position. When the individual switch is thrown to "off" it opens the connection to the snubber magnet and removes the battery for the associated snubber magnet and its snubber control relay. It shorts the associated motor circuit contacts of the motor control relay to restore normal motor operation and closes the circuit through the No. 2 tongue and front contact of the snubber control relay.

Recapitulation

Assume all tickers running and all tape-puller motors operating. The tape of one unit becomes taut, opening the mercury switch and allowing the snubber control relay to become energized. All snubber magnets are energized and following this all mercury switches are opened and all motors stopped. The motor control relay is energized and locks up. All motor circuits are now opened at a second point. All snubber magnets are deenergized releasing the tapes. All mercury contacts are closed and all snubber relays are deenergized. The motor control relay is now deenergized closing all motor circuits. All motors start together and continue to pull tape until one of the mercury switches is opened by taut tape when the above cycle is repeated.

The installation has been in operation for some months and has proved completely satisfactory.

A biographical sketch of the author appears in the July 1949 issue of TECHNICAL REVIEW

CHARLES R. TILGHMAN*

Telegraph History

SOME EARLY DAYS OF WESTERN UNION'S STOCK TICKER SERVICE 1871 — 1910

The Western Union Telegraph Company had been established only 15 years when Charlie Tilghman was a "stock" messenger in Cincinnati, Ohio. The story, as he tells it briefly, of early developments in Western Union's ticker service is a story also of his own resourceful rise to the position of General Superintendent of Ticker Services.

About 1871 or '72 when I was a stock messenger in the Cincinnati office, the Gold and Stock quotations were received by Morse from New York and copied on manifold sheets and each boy had ten or twelve subscribers to deliver reports to every fifteen minutes. Gold was at a premium and was bought and sold like stocks, so we had the name of Gold and Stock Telegraph Company

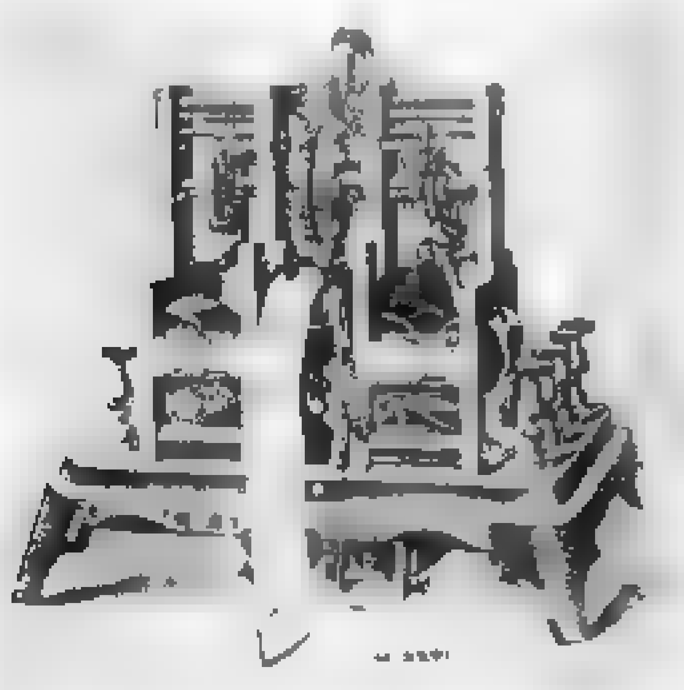

Photo M 1.91

E. A. Calahan's 1867 stock ticker introduced by the Gold and Stock Telegraph Co. required three line wires.

One day, our "boss" told us boys that they would not need us any more as they were going to send out the reports on electric printing machines. In a few days the equipment for a small ticker plant was received, including a dial transmitter with letters and numerals in a circle, an arrow or pointer pivoting in the center. The turning of a small crank operated a make-and-break contact point and also revolved the arrow, stopping it directly over the character desired. The operator pressed a telegraph key with his left hand to close the press circuit and print the character. Six tickers were received. They were Edison's invention with type and press magnets of six ohms each and required a large amount of current to work them. There was a ratchet wheel on the type wheel shaft. An arm, extending from the type magnet and working perpendicularly into this ratchet wheel revolved the type shaft and the two type wheels on the end of it.

I took a great interest in the machine, helped to set one up on a short circuit in our office and commenced to practice working the transmitter. In a short time, one machine was put in the First National Bank and two wires were run from our office to connect it. The bankers, brokers, and business men were invited to see the new wonder of printing by electricity. A crowd came and I operated the transmitter, sending out stock quotations. It created quite a lot of excitement and talk Soon the Company had several subscribers signed up and a ticker plant started—I was the operator. This Edison ticker became known as the Universal ticker.

We operated these tickers ten years before we ever had a voltmeter or an ammeter or anything to tell us how much current was on our lines. When we added

* Deceased

tickers, we added a few more cells and took them off when we cut out tickers. We had to judge the adjustments of relays and ticker by feeling the pull with our fingers.

Bunsen and Callaud Batteries

This was the start of ticker service in Ohio, and Cincinnati was the only town that had them. We used bichromate of potash and sulphuric acid solution in a porous cup set inside a circular zinc and a stick of carbon immersed in the solution. The zinc and porous cup were put in a glass of water diluted with a small amount of acid. This made a strong battery of very low internal resistance but expensive to maintain.

The company was using Callaud or blue vitriol batteries on the Morse wire and had twelve thousand cells in Cincinnati. The officials at Chicago were urging me to use the Callaud for ticker service, but I objected, saying it was too slow and had too much internal resistance for ticker work. The fight went on for some time. We did not have any dynamos or motors of any kind in the Cincinnati office at that time and had no more room for Callaud batteries.

Finally, I got the idea I could use Edison light current to operate the tickers. I went to the Edison company, explained what I wanted to do, and asked them to run a special wire into our office and let me see what I could do with it. They ran in a single wire from their positive side of a three-wire system. We had no resistance lamps so I used Edison light bulbs and the small resistance boxes we had. The Edison current worked the tickers fine and, to make a long story short, I worked the entire ticker plant, local and main circuits, with this current. This was in 1880 When I started the first long distance ticker circuit, Cincinnati to Columbus, Ohio, 125 miles away, I required both polarities to operate the polar relay in Columbus; therefore the Edison company ran in a negative lead with no additional charge.

I also used Edison current to work self-winding clock circuits. Later I put it on the main switchboard in the Cincinnati operating room and worked about fifty single lines and several duplex. To do this it was necessary to buy Edison lamps and make a lamp board above the switchboard. As I could spend five dollars without additional authority, my city foreman made the boards and I bought five dollars worth of lamps and receptacles at a time It was necessary to take off two copper battery strips that ran across back of the board and then run wires from the lamp receptacles to the small disks. After this was completed and a reserve lead from Edison company secured, we eliminated three thousand cells of Callaud batteries and the acid ticker batteries, making a saving of over $3000 per annum. The Edison company had taken out their meter and given us a flat rate of twenty-five dollars per month

I wrote to Mr. G. B. Scott, Superintendent at New York, and asked him to have a piano key transmitter made with a motor to work on 110-volt D.C. After a lot of correspondence, they sent me a transmitter and motor for 110 D.C. and told me to be very careful not to let it burn up and be sure to let him know how it worked as it was the *first* one ever made to use Edison current.

Self-Winding Tickers

The self-winding ticker was invented by Mr George B. Scott, Superintendent of the Gold and Stock Telegraph Company in New York, and Mr. W. P Phelps of the Philadelphia Local Telegraph Company Mr. Phelps invented the automatic shift from letters to figures and vice versa by changing the polarity on the second or winding wire. This was a great improvement over all other styles of printer at that time. They were first called the Scott-Phelps ticker. In 1903, Mr. J. C. Barclay, then Assistant General Manager, wanted to change the ticker and make it smaller He called Mr. Jay R. Page from Chicago to New York for suggestions on the change; and, with Mr. Scott, they decided to put the escapement magnet and adjustment screws inside the ticker frame After this change the ticker was called the Scott-Phelps-Barclay-Page ticker.

My first experience with these tickers came when Mr. Barclay transferred me from Cincinnati, where I was Assistant Superintendent of the seventh district of the Central Division by appointment of Col. Clowry, to New York, May 1, 1904,

Photo R-1219

Later model of Calahan ticker now is in Western Union Museum, New York.

and made me general inspector of ticker service in all divisions. Up to this time, I had never even seen these tickers working for they had not been put into service in the west, and I knew not a thing about them. Yet the very first thing Mr. Barclay asked me to do was to make these two-wire tickers with four pairs of magnets in them work a long distance on one wire.

A single underground wire from the ticker plant under the stock exchange to the repair shop in the Supply Department on Franklin Street was assigned for the test. I started to connect up the relays and tickers and then go down and make the connections on the ticker panel at Broad Street. At the end of the third day, when I went down to our office and told Mr. Barclay that I had the tickers working on one wire but not completed, he said in a very cross voice, "Oh, what takes you so long; hurry up." I later learned that electricians and ticker men had worked for two months and spent two thousand dollars trying to work the tickers from New York to Boston and had given it up, saying it was impossible.

Long Distance Service

I understood the quadruplex and that night I thought of using the quad neutral relay to work the repeat and next morning I connected one up before market opened and received the full market all day O.K. on my fourth day of testing. I took the day's tape down to Mr. Barclay, who looked it over and said, "Let's go in and show President Clowry." Mr. Barclay told the president, "Now we have a one-wire long distance ticker and we can put tickers all over the country." That was the start. The next week, Mr. Barclay said, "Now Tilghman, put up a long distance stock ticker in Philadelphia."

All during my four days of testing, Superintendent Scott had stood by me watching everything I did and saying about once every hour, "You can't do it. It cannot be done."

When I went over to Philadelphia, the other inventor of the ticker, Mr. Phelps, said, "Mr. Tilghman, I will do everything I can to help you and would like to see it work, but it cannot be done. The ticker that will work from New York to Philadelphia does not exist; there is no such machine."

It was much harder to work over the ninety miles to Philadelphia because of the induction from other wires. I found that when the operator in New York would strike the repeat key thus taking the current off the line for a fraction of a second, the induction from other lines would cause the polar relay in Philadelphia to jump ahead two or three characters. I went back to New York and bridged the break of the repeat relay with adjustable rheostat, leaving just enough current on the line to hold the polar and type wheel on the character the operator was holding; then adjusted my neutral relay in Philadelphia so that it would break away over the light current and

repeat the character. Finally, we got it to work so that the keyboard operator in Philadelphia sent from tape of the New York ticker.

Photo R-4830

Thomas A. Edison's two-wire "Universal" ticker, much improved, was used for many years.

Then Barclay said, "Now go on to Baltimore and Washington." This was some task and required repeaters in the line. The installation took time and Mr. Barclay sent Mr. William Finn over to help me in order to hurry up the job. Mr. Finn certainly was a very fine man to work with and gave me some good advice about the use of condensers. It was finally accomplished and we worked to Washington, later extending the circuit to Richmond, Virginia.

And so the long distance service spread. In 1905, I went all over New York, Pennsylvania, Ohio, and Indiana securing subscribers for stocks and baseball. One year, I secured $29,000 worth of service before baseball opened. In February 1910, Mr. Barclay left the company and Mr. Atherton, a splendid man with a very kind disposition and big heart, took his place. I was transferred from General Inspector to Mr. Atherton's staff. That summer, Mr. Kitton and I had our first vacation. I had been in the service forty-one years.

Mr. Atherton died the next year and I went into the office of Mr. Yorke, a perfectly splendid man to work for; fair, and just to all. I was with him all during the war; and, while in his office, was given charge of the ticker repair shop. One day, Mr. Yorke spoke of the "alphabet ticker", meaning the Scott-Phelps-Barclay-Page ticker, and wanted to know if I couldn't give it a shorter name. He didn't like all those names. I replied, "Yes, we can call it the self-winding ticker". He said to do it and drop all those names. So it has been the self-winding ticker ever since. Mr. Yorke changed my title to General Supervisor of Ticker Service. I remained with him until Mr. Titley came and was made Vice President of the Plant Department, when I was transferred to his office. He was another grand man and it was a great pleasure and honor to be associated with him.

The Western Union Co. had thousands of Burry tickers for which they were paying the Stock Quotation Tel. Co. $3.00 per month rental which totaled approximately $35,000 per annum. These tickers cost $32.00 each to manufacture. At the same time the Western Union had a large stock of their own tickers in the Supply Department and the Superintendent of Supplies asked for authority to sell or destroy them. He said they would never be used and took up too much room. Later he asked if he could get rid of 100 a month until they were all gone. I said, no, we would use them to replace the Burry tickers and save the rental. The Burrys were not so fast as the self-winding tickers and would get way behind on active markets.

The first town I changed was Washington, then Baltimore, Albany, Syracuse, Rochester, Buffalo and many more. Boston was using 350 Burry tickers and Chicago 750. They also used the Worisching ticker that was owned by the Stock Quotation Co. It was years before we got all these rental tickers out of our service.

Superintendent Scott used two polar relays to work each self-winding ticker circuit. He said we could not possibly work with one on account of the spark on the points. These relays were 135 ohms each.

This made a great load on the transmitter and great retardation in the local circuit; also created lots of sparking on the break wheel of transmitter which was revolved in oil to keep from sparking and burning. I told Mr. Scott I had put in new self-winding plant in Washington using only one polar relay on each circuit and it was working all right. There was no sparking on relay points.

Photo R-7261

Messrs. Scott, Phelps, Barclay and Page all contributed to "Self-Winding" ticker design.

The Big Blow Out

The old stock ticker plant in the basement of the stock exchange was operated from a storage battery plant of 150 ampere hour cells and 350 volts, positive and negative. From these batteries there were two large size copper wires run around three sides of the ticker room. Smaller wires were connected with the larger wires and run direct to the points of the polar relays on the ticker circuit panels. The only fuse was one connected in each battery wire in the battery room.

One day in September 1910 there was a short circuit on one of the stock circuits that blew out the fuse, splitting the fuse block in pieces. This cut off the entire stock ticker service in New York and all over the country for the Morse operators in the Western Union operating room were sending in all directions from the ticker tape. This blow out made some blow up!

General Manager Brooks came hurrying into Mr. Athern's office and asked him to send me down to Broad Street to see what was the matter. Up to this time I had nothing to do with this New York plant as Supt. George B. Scott was in direct charge of it. I went down, investigated, came right back and made my report. Mr. Athern and Mr. Brooks both said for me to go back and take charge; do anything, order anything you need, only fix it so it will never happen again.

I ordered material and started the work with six or ten men immediately after market closed each day, and worked till 9:00 or 10:00 P.M. I had a fuse put in each battery wire and through a resistance lamp to every ticker circuit panel. I found every circuit in the plant had positive pole connected to unison so the entire load of about 75 or 80 amperes was on one battery lead. When I asked why they did not put half the load on negative, they said "Why you must be crazy, the tickers would not work". Well, I had it done nevertheless — and the tickers operated just as before.

Patents Recently Issued to Western Union

Shockproofed Facsimile Recorder

D. M. Zabriskie, F. L. O'Brien
2,961,287—November 22, 1960

Arrangement for reducing the potential to which facsimile operators may be exposed when recording on papers having a conductive mid-layer sandwiched between top and bottom nonconducting layers such as described in Patent No. 2,638,422. The method is particularly applicable to recorders wherein the paper is pushed, rather than pulled, through the recording area. For the purpose, star wheels with sharp points are located at each side of the web where they penetrate to the conducting layer. One wheel, ungrounded, serves as a return path for the stylus current while the other, grounded to the machine, maintains the conducting mid-layer at near ground potential.

Station Selection Repeater

H. F. Wilder, H. F. Krantz
2,963,550—December 6, 1960

In multistation telegraph systems normally operated by start-stop printers and in which a calling printer normally sends a 5-second open to condition the remaining connected printers for reception of a selection code, a method is provided for sending the 5-second open over an included section of circuit which is normally operated by synchronous multiplex apparatus. A "selection repeater" is provided at the multiplex sending station which responds to the 5-second open and translates it into a mark pulse of 5-unit length for transmission over the multiplex section while another device at the multiplex receiving station performs the inverse function of detecting the 5-unit mark and translating it into a 5-second open for retransmission over the connected start-stop lines.

Multiplex to Teleprinter Translator

H. F. Wilder, G. T. Fontaine
2,966,546—December 27, 1960

A multiplex to start-stop translator including blank deletion to prevent chatter of the teleprinter relay during reception of blanks over the multiplex circuit. Comprises a distributor bearing three segmented rings including a multiplex receiving ring of five segments per channel, a seven-segment start-stop sending ring timed immediately to follow the first ring, and a reset ring having three distributed narrow segments aligned with the sending ring. Five leads from the receiving segments traverse the five primary windings of a first transformer to charge five storage condensers which are arranged to discharge via five of the seven primary windings of a second transformer and thence to ground via the five-character segments of the second ring. The start and stop pulses are added via windings one and seven respectively of this transformer and the signal train passes then via a chain of trigger circuits to the teleprinter relay. A second chain of trigger circuits also fed by the first transformer is arranged to block the first in the event that the received character includes no marking pulses (blank) but is prevented from doing so if a marking pulse is present. The reset segments restore normal biases to the tubes of the second trigger circuit at the end of each character.

Delay and Amplitude Corrective System

W. D. Cannon
2,966,633—December 27, 1960

A multisection active delay and amplitude correction network, each section comprising a bridge combination having fixed arms preferably of 3:1 ratio and adjustable arms including variable resistances, with one of them paralleled by a selective circuit, here shown as parallel resonant. Identical variation of the resistors provides delay adjustment while differential variation controls attenuation. A succession of sections uniformly spaced frequency-wise provides compensation over a wide band. The successive networks are coupled together by a step-down transformer energizing a two-transistor combination having a high impedance output adapted to match the input of the succeeding section.